Management and Mitigation of Acoustic Impacts on Marine Mammals

Partial Draft Report (v. 3) for Subcommittee Review

Developed by

Subcommittee on Management and Mitigation
Advisory Committee on Acoustic Impacts on Marine Mammals

08 November 2004

New text (not yet reviewed by Subcommittee) highlighted in green

DRAFT PRODUCT -- DO NOT CITE

TABLE OF CONTENTS [to be completed]

I. Introduction [This section may be expanded later]

Requirements for the management and mitigation of acoustic impacts on marine mammals have been the subject of considerable debate and regulatory activity in recent years. One of the key issues is how current management and mitigation approaches could be improved to address the concerns of all stakeholder groups.

This report will examine the components of the management and mitigation systems, describing what mechanisms and methods currently exist and where they may need improvement. It will then summarize existing statutory requirements for management and mitigation, discuss the extent to which various anthropogenic sound sources are currently subject to management, and review the components of management systems, including knowledge and information bases, risk assessment, permitting and other regulatory actions, mitigation tools, monitoring and evaluations, and enforcement. The report will also outline current policy issues concerning the management of acoustic impacts on marine mammals and propose recommendations for workable solutions to current concerns.

A. Definitions and purposes of management and mitigation of acoustic impacts on marine mammals

For the purposes of this report, management and mitigation will be defined as follows:

> ***Management*** will refer to the full process of assessing, evaluating, permitting, mitigating, monitoring, and enforcing compliance for acoustic impacts on marine mammals from anthropogenic sound sources,. The components of management discussed in this report will include knowledge, information, and research; risk assessment; permitting and other regulatory processes; mitigation tools; enforcement and compliance (including reporting); and monitoring and evaluation.

> ***Mitigation*** will refer to the use of a suite of tools and activities undertaken to prevent, reduce, eliminate, or rectify the impacts of both intentionally and unintentionally introduced anthropogenic sound on marine mammals.

One of the key debates in the discussion of management and mitigation concerns the degree to which the overarching goal should be to reduce overall levels of the anthropogenic component of ambient noise in the marine environment, which may have effects on marine mammals over the long term, or to address specific impacts from specific activities that are known to harm marine mammals. Conflicting opinions also arise over whether the intention should be to reduce such exposures to negligible or insignificant levels, to minimize these exposures to the extent feasible, or to achieve some combination of these.

B. Vision for ideal management and mitigation system *[This section may be best placed in the later discussion of Potential Recommendations.]*

C. Acceptable Risk and Uncertainty in Management Systems

[This section refers to risk tolerance and should include: (1) Brief comments about uncertainty in information (referring to the Information and Research Section); (2) Rationale for precautionary approaches (*e.g.*, limits to current scientific knowledge and information, need for policy decisions in the absence of complete information, etc.); (3) discussion of how "best practices" and mitigation measures should be applied in light of uncertainty. A reference should be made to the discussion of risk in the Risk Assessment section of this report.]

II. Description of the Requirements for Management of Impacts

A. Statutory Basis for Management of Impacts (U.S. law)

Management of the impacts of anthropogenic sound on marine mammals is required and regulated under multiple U.S. statutes. With regard to marine mammals, much of the authority for regulatory oversight of such impacts arises from the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). The MMPA and ESA are implemented by the National Marine Fisheries Service (NOAA Fisheries) and the U.S. Fish and Wildlife Service. NOAA Fisheries is responsible for dealing with all marine mammals except for the eight species within U.S. Fish and Wildlife Service jurisdiction: polar bear, walrus, sea otter, marine otter, manatee (3 species), and dugong. Other statutes that play key roles in the management system for marine mammals include the National Environmental Policy Act (NEPA), administered (with respect to marine mammals) by NOAA Fisheries or U.S. Fish and Wildlife Service (hereafter referred to as "the agencies") as above; the Outer Continental Shelf Lands Act (OCSLA), administered by the Minerals Management Service (MMS); and the Coastal Zone Management Act (CZMA), implemented by NOAA Fisheries and coastal states. A variety of other statutes relevant to the management of marine mammals or the regulation of sound-producing activities are also briefly summarized.

1. Marine Mammal Protection Act (MMPA)

The Marine Mammal Protection Act of 1972[1] sets forth a national policy to prevent marine mammal species and population stocks from diminishing, as a result of human activities, beyond the point at which they cease to be significant functioning elements of the ecosystems of which they are a part. The MMPA mandates an ecosystem approach to marine resource management, although it also deals with specific species. In the MMPA, Congress directed that the primary objective of marine mammal management should be to maintain the health and stability of the marine ecosystem and, when consistent with that primary objective, to obtain and maintain optimum sustainable populations of marine mammals.

The Marine Mammal Protection Act is the country's primary instrument for the conservation of whales, dolphins, sea otters, and other species. By 1972, when the Act was first adopted, many of these species had been hunted to the verge of extinction, and their habitat had been degraded to such an extent as to impede recovery. Congress concluded that "certain species and population stocks of marine mammals are, or may be, in danger of extinction or depletion as a result of man's activities," and, further, that "[t]here is inadequate knowledge of the ecology and population dynamics of [marine mammals] and of the factors that bear upon their ability to reproduce themselves successfully."[2]

The MMPA states that marine mammals are significant cultural and biological resources, that there is inadequate knowledge of their ecology, and that populations have been diminished due to human activities.[3] As a result the MMPA provides a general moratorium on the "taking" and importing of marine mammals and marine mammal products (subject to a number of exceptions).

Under the MMPA, "take" means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal."[4] The term "harassment" is currently defined in the MMPA as "any act of pursuit, torment, or annoyance which:

- has the potential to injure a marine mammal or marine mammal stock in the wild [Level A]; or
- has the potential to disturb a marine mammal or a marine mammal stock in the wild by causing disruption of behavioral patterns including, but not limited to, migration, breeding, nursing, breathing, feeding, or sheltering [Level B]."[5]

The U.S. military and any research conducted on behalf of the federal government are, however, subject to the following different definitions of harassment [emphasis added]:

- Level A: "any act which injures or has the *significant* potential to injure a marine mammal or marine mammal stock in the wild"; or
- Level B: "any act which disturbs or *is likely* to disturb a marine mammal or marine mammal stock in the wild by causing disruption of *natural* behavioral patterns, including, but not limited to, migration, *surfacing*, nursing, breeding, feeding or sheltering, *to a point where such behavior patterns are abandoned or significantly altered*".

Thus, to the extent that anthropogenic sound can cause a marine mammal take, such sound is subject to the requirements of the MMPA. The act authorizes the agencies to issue permits for taking marine mammals for scientific research that meets specific requirements,[6] and to authorize incidental takings for activities "within a specified geographical region… during periods of not more than five consecutive years…" in cases where "the total of such taking… will have a negligible impact on such species and will not have an unmitigable adverse impact…[and the activity prescribes to]… methods… affecting the least practicable adverse impact…; and requirements pertaining to the monitoring and reporting of such taking."[7]

2. Endangered Species Act (ESA)

The Endangered Species Act of 1973[8] establishes the national policy for the protection and conservation of threatened and endangered species and the habitats on which they depend. The ESA declares that "fish, wildlife, and plants are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people," adding that "the United States has pledged itself… to conserve to the extent practicable the various species… facing extinction."[9] Requirements for compliance are principally contained within two sections of ESA, as described below.

Section 7(a)(2) of the ESA[10] requires federal agencies to consult with the agencies,[11] when there is reason to believe that a species listed (or proposed to be listed) as endangered or threatened may be affected by a federal action. Depending on the potential impacts, such a consultation may produce a biological opinion based on "the best scientific and commercial data available" to ensure that any action funded or carried out by a Federal agency "is not likely to jeopardize the continued existence of any [listed] species or result in the destruction or adverse modification of [critical] habitat of such species."[12] The biological opinion may include recommended reasonable and prudent measures designed to mitigate impacts of the proposed activity.

Section 9 of the ESA[13] contains prohibitions on takings of any endangered species of fish, wildlife, and plant by any party (not just federal agencies as under Section 7), with certain specified exceptions.[14] According to the ESA, "take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct."[15] The same restrictions can also be applied to threatened species through the use of regulation.[16] Activities exempted from these restrictions are still required to provide "reasonable mitigation and enhancement measures."[17]

In the event of a conflict between the provisions of the ESA and the MMPA, the Act stipulates that the ESA does not take precedence over any provision of the MMPA that is more restrictive.[18]

3. National Environmental Policy Act (NEPA)

The National Environmental Policy Act of 1969[19] is the foundation of environmental policy-making in the United States. The purpose of NEPA is "to declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; [and] to enrich the understanding of the ecological systems and natural resources important to the Nation."[20]

NEPA requires all federal agencies to employ a systematic, interdisciplinary approach to protect the human environment and ensure the integrated use of natural and social sciences to assess the environmental impacts of federal actions. Federal agencies are required to review any proposed program or decision to ascertain its potential of "significantly affecting the quality of the human environment."[21] This process is intended to help federal officials make decisions based on an understanding of the consequences those decisions will have for the environment, and to take actions that protect, restore, and enhance the environment. NEPA also established the Council on Environmental Quality (CEQ) to advise federal agencies on the environmental decision-making process and to oversee and coordinate the development of Federal environmental policy.

Federal agencies are required by NEPA to produce a review of potential environmental impacts of the activities they conduct, fund, or permit (including legislative proposals). The briefest form of NEPA review is the categorical exclusion review, which identifies categories of activities for which an Environmental Assessment (EA) is not needed because these classes of activities do not generally have potential to significantly affect the quality of the environment.[22] If preparation of an EA is warranted and that EA does not result in a "finding of no significant impact," then a more comprehensive Environmental Impact Statement (EIS) is needed before making a decision on the activity being considered for approval. An EIS must include description and analysis of any adverse environmental effects that cannot be avoided or mitigated, alternatives to the proposed actions (including "no action"), the relationship between short-term resources and long-term productivity, and irreversible and irretrievable commitments of resources. Agencies are required by NEPA to identify data gaps during the EA/EIS process and to fill such gaps where possible.[23]

According to the CEQ regulations,[24] the analysis of alternatives is the heart of the entire EIS process, allowing NEPA to fulfill its purpose of proactively building environmental concerns into the decision-making process. Under NEPA, the potential impacts of anthropogenic sound are one area for which the effects of federal actions and programs on the environment must be considered.

[The Subcommittee may wish to include additional text re: Programmatic EIS's in the Policy Issues Section and add reference to it from here. That topic is also under discussion by the Permitting Workgroup.]

4. Outer Continental Shelf Lands Act (OCSLA)

The OCSLA[25] establishes federal jurisdiction over, and federal ownership of, submerged lands on the outer continental shelf (OCS) seaward of state boundaries. OCSLA is designed to promote responsible development and use of the natural resources of the OCS and sets up a framework for granting leases for exploration and development. As the implementation of OCSLA is administered by MMS, all reviews of oil and gas leases under OCSLA must also comply with requirements for federal actions under the MMPA, ESA, and NEPA. Lease conditions may therefore include requirements related to the impacts of anthropogenic sound upon marine mammals.

5. Coastal Zone Management Act (CZMA) as amended 2002

The Coastal Zone Management Act of 1972[26] created the Coastal Zone Management Program to improve the management of the nation's coastal areas through voluntary partnerships between the Federal government and the coastal states and territories. One of the CZMA's main goals is to reduce conflict between environmental and economic interest in the coastal areas. It declares that it is the national policy to "preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations" through federally approved state-based coastal management plans and programs.[27] These programs must set forth objectives, enforceable policies, and standards to guide public and private uses, with which any future (development) project should be consistent "to the maximum extent possible."[28]

Under the CZMA, any proposed federal activities in a state's coastal zones must be consistent with the state's Coastal Zone Management Program. State agencies may object to the granting of a "consistency certification" if any proposed federal activity is inconsistent with their programs, and may suggest alternative activities. There are also provisions in the CZMA for a state agency to request a federal agency to take remedial action if an unexpected effect occurs. This right also extends to activities regulated by the OCSLA. However, if the state's objections are to activities deemed "necessary in the interest of national security,"[29] additional information provided by the Department of Defense or other interested Federal agencies will be reviewed. While not binding, such reviews are given considerable weight.[30]

States vary widely in their implementation of the CZMA. All states have the authority to review federal activities through consistency certification and review both in and outside of state waters including the OCS, but differ in the manner in which they apply this authority. For example, some states have a single agency that holds direct coastal permitting and regulatory authority, while others have a lead agency that coordinates a network of other state agencies. In addition to the review of federal action, states may also implement their own regulations under the CZMA, which may relate to sources of anthropogenic sound or their effects on marine mammals. This results in a patchwork of regulations and processes throughout the states (see Policy Issue Section).

6.Additional Legislation Relevant to the Management of Acoustic Impacts

There are several additional statutes that may be relevant to acoustic impacts on marine mammals in particular situations. For example, the Deepwater Port Act (DPA)[31] and the Ocean Thermal Energy Conversion Act (OTECA)[32] deal with the concerns related to specific projects, while the Rivers and Harbors Appropriation Act (RHAA)[33] deals with general construction in any navigable US waters. Additionally, the Fur Seal Act (FSA),[34] a predecessor of the MMPA, controls taking of the North Pacific fur seal[35] while the Marine Minerals Resources Research Act (MMRRA)[36] promotes research, identification, assessment, and exploration of marine mineral resources in an environmentally responsible manner. Finally, two presidential proclamations have established federal jurisdiction over territorial waters up to 24 nautical miles from the coast.[37]

B. International Regulatory Requirements

[This section to be drafted after the Subcommittee has discussed the results of the International Policy Workshop.]

III. Sound-Generating Activities Subject to Management

Human activities that generate sound in the marine environment include:

- commercial shipping;
- oil and gas exploration, development, and production (*e.g.*, airguns, ships, drilling, and dynamic positioning);
- naval operations (*e.g.*, military/tactical sonars, communications, and explosions);
- fishing (*e.g.*, commercial/civilian sonars, acoustic deterrent and harassment devices);
- research (*e.g.*, airguns, sonars, telemetry, communication, and navigation); and
- others such as construction,[a] icebreaking, over-flying aircraft, and recreational boating.

Anthropogenic sound sources and their characteristics were covered in detail in the Synthesis of Current Knowledge Report. The specific sources of anthropogenic sound discussed in that chapter include:

[a] While pile driving during installation of windmills is a significant source of anthropogenic sound, the Synthesis Subcommittee believes that operating windmills are not a significant source of anthropogenic sound. Received levels at 110m were broadband max <120 dB re 1µPa, max third octave 110 dB re 1µPa. (Assuming spherical spreading SL<160dB re 1µPa.)

- Ships
- Powerboats
- Overflying aircraft
- Drilling
- Tunnel boring
- Marine dredging
- Pile driving
- Explosions
- Airgun arrays
- Military sonars
- Civilian or commercial sonars
- Research sonars and sound sources (*e.g.*, acoustic thermometry,[b] echosounders, multibeam sonar)
- Acoustic Deterrent Devices (ADDs) and Acoustic Harassment Devices (AHDs)
- Acoustic communication and navigation devices

A. Current Extent of Management and Mitigation of Sound-Generating Activities

Under current U.S. laws, all taking of marine mammals is illegal unless otherwise authorized or exempted. However, not all sources of sound or sound-generating activities are managed, regulated, or mitigated to the same extent. This variation in regulation is due to a variety of factors.

1. Intentional Versus Incidental Production of Anthropogenic Sound

Sound is an important tool intentionally used for a variety of purposes by humans interacting with the marine environment. For example, military and commercial sonars are used to detect and locate objects in the water column, and Acoustic Deterrent Devices are used to discourage marine mammals from approaching fishing gear or aquaculture facilities. The intentional, deliberate introduction of sound into the marine environment can thus have important benefits for humans. Intentionally introduced anthropogenic sound sources include (in alphabetical order):

- Acoustic communication and navigation devices
- Acoustic Deterrent Devices (ADDs) and Acoustic Harassment Devices (AHDs) (*e.g.*, “pingers” to prevent cetaceans becoming entangled in fishing nets)
- Airgun arrays
- Civilian or commercial sonars
- Military sonars (*e.g.,* 53C Mid-Range, SURTASS LFA)
- Research sonars and sound sources (*e.g.*, acoustic thermometry, echosounders, sub-bottom profilers, multibeam and sidescan sonar)

On the other hand, many human activities in the marine environment produce sounds unintentionally or as a by-product of other intentional activities. Such sounds have no direct benefits for humans, although the activities that produce the sounds can be of great importance. Incidentally introduced anthropogenic sound sources include (in alphabetical order):

[b] Acoustic thermometry experiments include the Heard Island Test, ATOC/NPAL source, etc.

- Drilling (*e.g.*, minerals extraction)
- Explosions (*e.g.* from demolition and construction activities)
- Marine dredging
- Overflying aircraft (e.g. some oil and gas industry, military, and marine mammal research-related flights, airliners and air cargo, etc.)
- Pile driving
- Powerboats (*e.g.* commercial fishing, private boats, personal water craft)
- Ships (*e.g.* tankers, cargo vessels, cruise ships)
- Tunnel boring

In addition to the sources described in detail by the Subcommittee on Synthesis of Current Knowledge, icebreaking, missile and rocket launches/propulsion systems, and vehicles (*e.g.* arctic vehicles, cars and trucks over bridges) can also incidentally introduce sound into the marine environment.

2. Regulated and Unregulated Sources of Anthropogenic Sound[c]

The agencies regulate the production of sound for those entities that approach them for authorization to take marine mammals in the course of their activities. In some cases, entities that introduce sound to the marine environment have not sought authorization and are thus currently unregulated. In recent years, the agencies have authorized incidental harassment of marine mammals for the following sound sources:

- Certain aircraft over-flights (*e.g.*, some oil and gas industry, military, and marine mammal research-related flights, etc.)
- Airguns (*e.g.*, seismic surveys – may be single or used in an array)
- Explosions (*e.g.*, from demolition and construction activities)
- Military sonars (*e.g.*, SURTASS LFA)
- Mineral extraction (*e.g.*, oil and gas platforms)
- Missile/rocket over-flights
- Offshore construction or demolition noise (*e.g.*, pile driving)
- Research (*e.g.,* acoustic thermometry)
- Sub-bottom profilers
- Vehicles (*e.g.*, arctic vehicles)

Those engaged in the production of sound from the following sources have not routinely sought authorization for incidental harassment of marine mammals for the sounds they produce:

- Acoustic Deterrent and Harassment Devices (*e.g.*, "pingers" to prevent cetaceans becoming entangled in fishing nets)[d]
- Commercial (airliners and air cargo) and other aircraft over-flights
- Commercial/research sonars (*e.g.*, multibeam sonar, GLORIA-type sidescan sonar)
- Echosounders
- Small vessel noise (*e.g.*, commercial fishing, private boats, personal water craft)
- Icebreaking

[c] Drawn from the Table of Mitigation Tools, Synthesis of Current Knowledge, and NRC 2003
[d] Interestingly, the use of ADDs or AHDs is in some cases *required* by the agencies as part of mitigation for fisheries activities.

- Large vessel noise (*e.g.*, tankers, cargo vessels, cruise ships)
- Vehicles (*e.g.*, cars and trucks over bridges)

B. Examples: application of management and mitigation to specific sound sources

[Subcommittee needs to discuss whether to include 2-3 examples of how M&M are applied in specific cases]

IV. Components of Management Systems

A. Introduction

(Overview of how components fit together – to be drafted, including a graphic description)

B. Knowledge, Information, and Research

Quality information is required at multiple points throughout any environmental management system for making useful and practical decisions. For management of impacts of anthropogenic sound sources on marine mammals, managers need information about the animals, the sources, and the interactions between the two (*i.e.*, potential impacts). In the management of acoustic impacts on marine mammals, the information available (our knowledge) for many aspects pertinent to this issue is nowhere near the level needed to make reliable decisions. The report of [chapter on] the Synthesis of Current Knowledge reviews the current state of our knowledge concerning the biology of marine mammals, the various sound sources to which they may be exposed, and the types and potential mechanisms of effects. The key uncertainties that exist in our understanding of these subjects are also described. These uncertainties pose significant challenges for management systems. As a result, managers and regulators will continue to identify information gaps where they find insufficient data are available to make good decisions, and communicate these gaps to the scientific community.[38]

Research also plays a critical role in management systems. It provides the means to develop new information, and is especially useful to managers in adding to data in areas where they are lacking, and in improving the quality or quantity of available information where there is uncertainty or dispute. Research can be defined as the process of gathering information by way of the scientific method, which is discussed in detail in the Synthesis of Current Knowledge Subcommittee Report [Chapter]. It is important to note that, for a variety of reasons, not all research completes every step of the scientific method. For example, research does not always require experimentation and may rely entirely on observational research or other investigation techniques. A broad variety of activities may be considered research, including:

- technology development (*e.g.*, "research and development" investigations to develop mitigation techniques);
- mission-based investigations conducted by government agencies, industry groups, and others (*e.g.*, stock assessments, preparation of environmental assessments, evaluating mitigation effectiveness);
- spontaneous innovation (*e.g.*, unexpected breakthroughs or imaginative applications of technology); and
- traditional academic research carried out in the laboratory or in the field (*e.g.*, characterizing normal behavior, identifying critical habitat, modeling sound propagation).

It is also important to realize that not all information is produced through science, and not all decisions in policy-making or management are based on scientific knowledge; political, economical, social, and other types of information are also involved. Consequently, it is important, for the sake of transparency, to identify when these other factors have been given priority in management decisions.[39]

The list of research needs for the mitigation and management system is very long, ranging from basic research about marine mammal distribution to applied research on the effectiveness of mitigation techniques. Many management questions require long term monitoring of the environment for ambient noise, populations and distribution (including seasonal variations) of marine mammals and sound sources, and baseline information about normal marine mammal behaviors.

1. Information Needs of Management Systems

Specific information needs vary from one case to another, but all managers require a minimum knowledge base that identifies and describes:

- marine mammals and their habitats,
- the threats to individuals and populations of marine mammals due to sound exposures, including potential mechanisms of disturbance or harm, and
- the sources of the threats (*i.e.*, sources of sound involved).[40]

Sound producers, permit applicants, and permitting agencies usually develop this information for the regulatory system. For example, NOAA Fisheries requires information about fourteen elements from parties requesting a take authorization (see Box 1).

a. Information About Marine Mammals and Their Habitats

The management of anthropogenic sound sources and their impacts on marine mammals begins with detailed information about the existing natural systems. The potential environmental costs arising from a particular action cannot be accurately determined without first understanding the components of these systems. For the purposes of this report, the main components of concern in the natural system are marine mammals and the ecosystems of which they are a part. However, the characterization of existing "normal" conditions for marine mammals is a major challenge, because natural systems are global and dynamic, involving fluctuating populations and behaviors and constantly changing habitats. Informed decisions require a detailed understanding of the ranges and patterns of change for these shifting elements. It is also difficult to distinguish between "natural" and human-caused environmental variability, especially in cases where habitats were already significantly altered before any information was collected. As a result, current conditions cannot necessarily be accepted as the baseline for comparison and evaluation of impacts.

Marine mammal abundance. Marine mammal abundance is a key indicator of population status,[41] but has yet to be estimated for many stocks and species. In addition, estimates for some stocks or species are too imprecise to support conclusions about population trends. The agencies are responsible for developing stock assessments for marine mammals. The accurate determination of abundance generally requires well-structured surveys, long-term studies and monitoring, and a reasonably large research effort to adequately characterize natural changes from season to season and year to year. Because these assessments are often incomplete and imprecise, management decisions are often required in the absence of information about the effects of various factors on marine mammal populations, or the effectiveness of conservation measures.

Marine mammal abundance data also provides an example of the need for careful application of information to the management process. Some research has shown that the use of “best estimates” of abundance (*e.g*., means) in management decisions generally leads to failure to meet management objectives.[42] On the other hand, the use of minimum estimates for abundance may be more likely to result in achievement of management goals because it essentially employing a precautionary approach in the face of uncertainty in population size.[43]

Biological information concerning species distribution, movements, and critical behaviors, such as feeding and reproducing, is also needed for management decisions. Much of this information is not available (see Synthesis Report).

b. Information About Threats to Marine Mammals Due to Sound Exposure

Information about marine mammal responses is needed to determine the extent to which the animals are at risk from acoustic exposure. The level of risk is case-specific, because responses will vary based on the animals and sources involved and other specifics (see Synthesis Report). Details of the cumulative effects of exposure to multiple types of sound (concurrently or sequentially), as well as sound exposure in combination with other factors (*e.g.* fisheries bycatch) are also needed. Similarly, information regarding less direct responses to sound is also required, as marine mammals are part of an ecosystem and can be affected by changes to various parts of that system. Behavioral responses are an important element of the knowledge base required by managers, yet it is difficult to obtain the information needed for the many species of marine mammals that managers must protect. Much of this information is not available.

c. Information About the Sources of the Threats to Marine Mammals

It is important to know the characteristics of sound signals (*e.g.*, amplitude, frequency, duration, rise-time) involved in any activity, because these help determine the impacts a source may have on marine mammals. Fortunately, there is a relatively large amount known about this topic compared with the other information needed by managers. However, one area in which more information is needed relates to the contributions of various sources to the total level of sound in the ocean environment. This information is important for assessing cumulative impacts, as well as more subtle impacts such as masking.

In addition to information about the sound, managers also need to know why the sound is to be produced. Any proposed sound-producing action is motivated by the expected or perceived gain resulting from taking that action; if there were no benefit, there would be no action. The uses of the marine environment (*e.g.,* for oil and gas exploration or marine transportation) inevitably change over time as new technologies and techniques are developed. Entirely new ways to utilize elements of the marine environment may be created, or improvements in efficiency may change the extent or pattern of use. Resource users can provide managers with the relevant information about their rationale for undertaking an action and the potential benefits involved.

d. Information About Management Methods and Mitigation Tools

In addition to the general management information needs detailed above, managers need a working knowledge of the effectiveness of the various approaches, technologies, techniques, and mitigation strategies under the various possible conditions so that the strategies can be improved, and so that a reduction in impacts can be achieved to the maximum extent practicable.

Management plans themselves can be evaluated, a process that is necessary to determine if an action is successfully fulfilling its purpose.[44] To do this, measurable management goals are needed. The information required to evaluate a management effort must be tailored to each specific situation. Most marine mammal management efforts have the chief goal of preventing or minimizing harm to the animals. Unfortunately, it can be very challenging to assess the extent to which this goal is reached, largely because the likelihood of detecting all detrimental effects upon marine mammals is small. As a result, it is often easier to conclude that a management effort failed (*e.g.*, because 200 marine mammals washed up dead on a beach) than to conclude that it was an outright success (*e.g.,* no detrimental effects occurred). Repeated non-failure adds validity to a management measure and, regardless of the specific goals, one of the simplest ways to determine effectiveness is to monitor and compare the situation before, during and after the activity concerned.

2. Role of Research in Management and Mitigation

Research plays an important role in the management system as the primary means of gaining useful information needed for policy decisions. As noted earlier, the Report [chapter] of the Subcommittee on the Synthesis of Current Knowledge outlines research needs for assessing acoustic impacts on marine mammals in detail. In this section we will highlight the interaction between the research process and the management system.

Broadly defined, research activities useful to managers include opportunistic information gathering, systematic data collection, experimentation, and modeling.

a. Opportunistic Information Gathering

Opportunistic studies are generally unplanned, non-systematic attempts to make scientific observations. They are an important means of recording new or unstudied phenomena, and can help scientists develop hypotheses and gather usually hard-to-obtain data about marine mammals and their responses to sound. For example, live strandings of rare or deep-water species can provide access to little-known animals for testing their hearing, making recordings of the sounds that they produce, or investigating other aspects of their biology. Both live and fresh-dead stranded animals can also provide valuable opportunities for examining physiological and anatomical issues related to the effects of sound. Despite the value of such information, it can be difficult to draw conclusions from data that are not systematically collected. For example, stranded animals may not be representative specimens. In addition, opportunistic studies on marine mammals can be difficult to carry out because of legal and ethical concerns; researchers must have the necessary permits in place before they can study an animal, and animal welfare concerns must be considered in any case.

b. Systematic Data Collection

Unlike opportunistic information gathering, systematic data collection involves prior planning for monitoring or methodically making observations. Examples of such studies, which do not involve experimentation, may include stock assessments and simple tagging studies. Systematic observational studies can reveal information about marine mammal distribution, movements, and behavior, and thus can contribute greatly to any assessment of potential impacts. Because of their rigorous nature, systematic observations can allow for more robust conclusions to be drawn.

Systematic monitoring can be involved in determining the relative effectiveness of mitigation tools. For example, as data are accumulated, general trends may become apparent, indicating that one method may be a better option (under certain conditions) than another method.

c. Experimentation

Experimental studies move beyond opportunistic and observational research, rigorously testing hypotheses and drawing conclusions. Much of the information managers need for decision-making must be developed through experimentation. For example, the identification of mechanisms for behavioral or physiological impacts requires that scientists move beyond observing these effects and conduct research to compare exposed animals to unexposed animals. Controlled exposure experiments (CEEs) examine the difference in behavior before, during, and after exposure to an acoustic signal. Studies of the effectiveness of mitigation techniques also rely on comparisons between impacts observed during mitigated and unmitigated activities. Experimental studies can also produce information about sound sources. For example, airgun calibration studies provide information about the sound propagation under different conditions (*e.g.*, water depth). Under current statutory requirements, researchers must obtain a permit before conducting experiments with marine mammals, as well as follow rules regarding animal welfare. Managers also take into account ethical concerns about marine mammal experiments.

d. *Modeling*

It is possible to use models to predict a variety of parameters and phenomenon, including biological and environmental systems (*e.g.*, marine mammals and their habitat) and their interactions with human activities (*e.g.*, sound production and its impacts). For example, scientists can model species distributions in unsurveyed areas by incorporating known habitat characteristics, species requirements, and prey distributions.[45] They can use models to identify regional changes in ambient noise on a global scale, or investigated the details of sound propagation for a particular scenario. By combining such models, it is possible to predict the likely exposure of an animal or population to a sound,[46] and, if enough behavioral information is available, also the probable response of the marine mammals. However, data needed to create and validate models are lacking for marine mammal impact analysis. The use of exposure models and concerns regarding uncertainties and assumptions incorporated in them are discussed in more detail in the risk assessment section of this report and in the Report [chapter] from the Synthesis Subcommittee. An increase in the information available for these models would be very useful, and the unfulfilled data needs discovered in the model development process can assist the management process in identifying key information gaps.

Modeling can also be used to evaluate efficacy of mitigation measures. For example, the potential effects of a mitigation tool can be applied to a modeled version of the ecosystem to allow the measure to be assessed without risking the environmental consequences of a failure. A model that incorporates information regarding several species in an ecosystem, including their preferred habitats, prey, and various behaviors could be used to run “experiments” on the possible effects of introducing, for example, an acoustic deterrent device to keep marine mammals out of a particular area where high level sounds are planned.

C. Risk Assessment

Risk assessment is a key decision-making tool for management of acoustic impacts on marine mammals, involving characterization of risks and appraisal of the probabilities that they pose a threat. Risk assessment tools and approaches range from the presentation of qualitative information to more comprehensive quantitative analyses. However, for the issues surrounding marine mammals and sound, data on which to base quantitative risk analyses are often lacking. Specifically, the availability of suitable and sufficient information about the various marine mammals and sound sources involved, the specific geography and physical characteristics of an area, and the known or probable consequences of sound exposure is often inadequate. The report [chapter] on Synthesis of Current Knowledge provides discussion of issues related to scientific uncertainty and disagreement relevant to risk assessment for marine mammals, including model assumptions, the use of extrapolation, etc.

Any party with an interest in the outcome of a particular activity may undertake a risk assessment, but such assessments are generally completed by either those producing the sound or by the federal agencies involved in their regulation. For example, in the US, the Minerals Management Service, NOAA Fisheries, and the U.S. Fish and Wildlife Service typically complete formal risk assessments under NEPA in the form of Environmental Assessments and Environmental Impact Statements. In addition, permit applications must be accompanied by information that addresses basic risk assessment questions, even if a formal assessment is not required. Not every party performing a risk assessment examines the same suite of potential impacts, and not every risk assessment measures against the same level of risk. However, the general process of risk assessments remains fairly consistent, as described below.

1. General Risk Assessment Processes

Regardless of the specific approach applied in a given case, there are three basic steps in the assessment of risk of impact on marine mammals from acoustic sources: 1) determination of exposure by identifying the distribution of marine mammals and their overlap with sound sources across space and time; 2) determination of the range of possible responses by the marine mammals potentially receiving the signal; and 3) determination of the likelihood of a specific undesirable outcome of exposure to the sound (*i.e.*, the risk).

a. Determining Exposure

Exposure assessment involves a detailed review of acoustic emissions and their propagation, and of the distribution and behavior of all marine mammal species, both spatially and temporally. Once this information has been gathered, it becomes possible to identify areas of overlap between the presence of marine mammals and anthropogenic sound. The more detailed information is available, the better this assessment will be. However, knowledge of global marine mammal distribution and behavior is limited, and interpolation and extrapolation techniques are often used to produce estimates for areas where data are limited.

b. Determining Response

The next step is to identify the range of possible responses of each species exposed to the various types of sound at various levels. For example, what are the potential auditory, non-auditory physiological, and behavioral impacts of exposure to a particular sound source? For marine mammal management, this stage of assessment is often guided by the MMPA and ESA, categorizing potential impacts according to the types of taking (*e.g.*, behavioral harassment or potential non-serious injury). Here the various types of sound signals, duration of exposure, and other source characteristics must be considered. The risk assessment must also identify impacts at all levels of concern, ranging from individuals to populations, and consider long-term, synergistic, and cumulative effects.

Another crucial part of the response determination process is identifying the mechanisms of potential impacts on marine mammals. Whether the mechanisms are physiological, behavioral, or indirect (*e.g.*, working through the food-chain), the acoustic characteristics related to each response must be isolated in order to make an accurate prediction of responses and overall risk. Where little is known about the specific mechanisms of impact for particular anthropogenic sounds (*e.g.*, new sources like high-speed ferries) there may be potential to make generalizations based on similarities to more well-known sources.

c. Determining Risk

By combining the predicted exposure characteristics with likely responses, managers can estimate the probability that an activity will exceed a given threshold of impacts for each exposed species. This can be done qualitatively (*e.g.*, by providing procedural guidelines or suggestions for mitigation measures) or quantitatively (*e.g.*, by detailing the specific probability of each impact occurring as a result of the planned activity). Quantitative measures of acoustic impacts are often based on assumptions about a specific spatial "zone of influence" (or impact). Uncertainty resulting from natural environmental variability, as well as deficiencies in our knowledge of the biological factors and site-specific physical properties involved, need to be considered and understood to provide accurate predictions of the risks involved. As a result, a comprehensive quantitative risk determination often requires the use of probabilistic methods, such as risk assessment models, coupled with uncertainty analyses. An important element of these risk assessments is an explicit description of the sources of uncertainty in their predictions, and detailed explanation of how managers can appropriately apply those predictions.

2. Risk Assessment Models

Models with clear, explicit assumptions are often useful in the risk assessment process. Whether conceptual or mathematical, models provide a means for integrating existing information on marine mammals, marine ecosystems, and sound sources and for fostering an objective appraisal of a situation. For example, they can help identify gaps in our understanding of marine ecology, test hypotheses about past events, and project the potential future effects of possible management strategies. In short, modeling is a key component of a quantitative and proactive management system that is based on the best available data.

Risk assessment models vary in their applicability and usefulness. The Office of Naval Research has funded the development of two models that are being developed for use in risk assessment: the Acoustic Integration Model (AIM) and the Effects of Sound on the Marine Environment

(ESME) model. They, like other models, have trouble with predicting the response of marine mammals to sound exposure. For example, likely behavioral responses are often unknown, and even in the rare cases where they can be predicted, the consequences of those responses are also unclear. Furthermore, it is difficult to make generalizations about risk, because the possible outcomes are specific to the times, places, and species involved. When such information is lacking, it is important to recognize uncertainty, temper the process by looking at similar cases in the past, and explain how the uncertainty was dealt with in the risk management process. Unfortunately, uncertainty is statistically cumulative, meaning that models that make more assumptions to deal with more unknowns are subject to more uncertainty. The greater the degree of uncertainty, the wider variety of outcomes is possible. Model uncertainty can be addressed through validating model predictions in the field, by examining the sensitivity of modeled results to variation in the model parameters, using of utility weighting, or other analysis techniques (*e.g.*, using Monte Carlo analysis or Bayesian statistics techniques). In short, although uncertainty can be estimated, models are only as good as the data on which they are based, and their use in regulatory or management decisions can therefore be controversial.

In spite of their limitations for use in management decisions, models can be useful tools for identifying data gaps and guiding research prioritization. For example, if adjusting acoustic source characteristics has little impact on predicted exposure levels, while small changes in marine mammal dive times are highly correlated with predicted exposure levels, then research into the biology of the species rather than the acoustic properties of the source may be a better investment.

Most of the analytical techniques needed for all three stages of quantitative risk assessment are already available, but knowledge remains a significant limiting factor. Our current knowledge is a tiny fraction of what we would need to know to inform robust risk assessment and effective risk reduction for acoustic impacts on marine mammals. As new data become available and uncertainty declines, updated risk assessment models will become more useful. As a result, any management or risk mitigation strategy supported by a data-poor risk assessment process will be subject to high levels of uncertainty.

3. Cumulative Impacts in the Risk Assessment Process

A comprehensive assessment of risk must consider the cumulative impacts of all human activities, not just those of a particular proposed project. Consideration of cumulative impacts plays an important role in for the achievement of conservation goals, as the overall impacts of sound exposure on a given animal or population are influenced by a wide variety of interacting or overlapping threats. For example, a population that is affected by fisheries interactions or disease may be more seriously affected by exposure to anthropogenic sound than would another population not subject to these additional threats.

[*Possible recommendation - All risk assessments should clearly detail the underlying uncertainties and assumptions involved, and bound what the assessment can and cannot tell policy makers*.]

4. Risk Tolerance

While the goal of risk assessment is to provide a probability that acoustic emissions will generate an impact or a suite of impacts, risk assessment cannot define what level of risk is acceptable. The determination of the tolerance of risk is a policy decision based on a variety of cultural, socioeconomic, and other factors and not strictly part of the risk analysis process. However, quantitative risk assessments are often used to help decision makers determine what level of risk is acceptable.

The determination of risk tolerance may involve one or a combination of decision-making tools. These include:

- Stakeholder negotiations (*e.g*., Advisory Committee on Acoustic Impacts on Marine Mammals) that assemble interested parties from various disciplines and task this group with reviewing available information and undertaking discussion to facilitate resolution of a given problem. External peer review process may be involved in some aspects.
- Expert panels (*e.g.*, the four National Research Council panels that recently addressed marine mammals and sound) of scientists that rely primarily on published scientific material to frame issues and identify gaps in current knowledge. The resulting reports are typically externally peer-reviewed and widely circulated.
- Expert opinion consultations (*e.g.*, the process employed by the High Energy Seismic Survey group) that gather a group of experts who must reach consensus on the bounds of a given problem. This approach typically does not use an external peer review process.
- Management review processes(*e.g.*, small take authorization decisions) that ask regulators within government agencies to make judgments specifically related to a given project.

In past efforts to determine the tolerance of risk, no matter which determination strategies were applied, the various methods often came to similar conclusions, including that there is a lack of essential data; that a precautionary approach should be taken in the absence of data; and that the absence of evidence does not necessarily translate into absence of effect.

Precautionary Approaches

[to be drafted after Subcommittee discussion, and perhaps after full Committee discussion at Plenary 4?]

D. Permitting and Other Regulatory Processes

[The suggestion was made that all the following procedural material should be reduced, combined with legal summary, or placed in an appendix. This should be discussed by the Subcommittee.]

1. Purposes

2. Who does it/for what activities/how?

3. Listing of permitting and regulatory processes in U.S., with summary and examples of international regulatory processes

a. Small Take Authorizations Under the MMPA[47]

Anyone who may unintentionally (incidentally) take a marine mammal must apply for a small take authorization from the agencies to be in compliance with the MMPA.[48] There are two major types of small take authorizations that allow takings of "small numbers" of animals that will have a "negligible impact" on the species or population stock: the Incidental Harassment Authorization and small take permits (including Letters of Authorization).[49] It should be noted that under this authorization system activities are reviewed independently of one another, which makes an assessment of cumulative impacts difficult.

Incidental Harassment Authorizations

Incidental Harassment Authorizations (IHAs) can be granted through a non-regulatory pathway for activities that do not have the potential to cause mortalities.[50] IHAs are issued for one year at a time and a full application must be resubmitted each year. If an animal is killed during the course of the activity for which an IHA has been granted, that activity must cease and a small take permit must be sought before it can continue. Because IHAs do not require the promulgation of regulations, they may be issued in as little as 120 days. Consequently, IHAs have been of increasing interest for relatively short-term activities that might unintentionally harass marine mammals. Although it is non-regulatory, the IHA process includes periods for public notice and comment, as well as review by the Marine Mammal Commission.

Small Take Permits

Letters of Authorization (LOAs) can be granted through a regulatory pathway for activities that may cause Level A or Level B harassment, or even mortality.[51] An application for a LOA is actually an application for the promulgation of regulations, meaning that the LOA process can take as long as 6-12 months to complete. Consequently, this type of small take authorization is normally granted for projects that are ongoing or have a time frame of 5 or more years and offer some of the comprehensiveness of programmatic analyses. The promulgated regulations are valid for 5 years and outline (1) permissible methods and the specified geographical region of taking; (2) the means of effecting the least practicable adverse impact on the species or stock and its habitat and on the availability of the species or stock for subsistence uses; and (3) requirements for monitoring and reporting, including requirements for the independent peer-review of proposed monitoring plans where the proposed activity may affect the availability of a species or stock for taking for subsistence uses. Once the regulations are published, the agencies grant an LOA that is generally valid for one year. The applicant must submit reports and request renewal of the LOA each year. The initial LOA application process includes specified periods for public notice and comment, as well as review by the Marine Mammal Commission.

Small Take Authorization Application Requirements

After it is determined whether a small take permit or IHA is more appropriate, the applicant must submit a written request to the agencies. This request must include a variety of information prudent to management decisions for consideration by the agencies (see Information and Research Section). If an authorization is granted on the strength of this information, various conditions can be attached requiring the applicants to undertake research, perform mitigation or conform to certain conditions.

b. Permits for Marine Mammal Research Under the MMPA[52]

The MMPA allows takings of marine mammals (by injury, mortality, or harassment) for "bona fide" scientific purposes. Researchers apply for a permit from NOAA Fisheries or U.S. Fish and Wildlife Service. The agencies publish a notice of receipt of the application and receive public comments, and review comments from the Marine Mammal Commission before issuing the permit. In the permit, the agencies may impose conditions (*e.g.*, reporting) intended to ensure humane treatment of the animals, negligible impact on the populations concerned, etc. This process takes a minimum of 60 days and has in rare cases taken as long as 2 years.

The 1994 amendments of the MMPA also allows general authorizations to be granted for "bona fide" marine mammal research that has the potential to cause only Level B harassment of non-listed species (species not threatened or endangered under ESA).[53] Researchers must file with the NOAA Fisheries or U.S. Fish and Wildlife Service a letter of intent to confirm that their activities may be appropriately conducted under the general authorization. For certain types of research, this streamlined process has alleviated delays associated with issuing permits.

c. Section 7 Consultations Under the ESA

Any takings of marine mammals listed as threatened or endangered under the ESA must also be authorized under the ESA through the U.S. Fish and Wildlife Service or NOAA Fisheries. In order for the take to be authorized, the acting federal agency must complete a Section 7 Consultation. The Consultation must result in a finding of "no jeopardy" or a non-jeopardy finding through "reasonable and prudent alternatives" for the activity to proceed.

Biological Assessments

The first step in the ESA authorization process is the completion of a Biological Assessment (BA). Although technically required under the ESA, the Biological Assessment requirement is often met through preparation of documents under other regulatory processes (e.g. an environmental impact statement or MMPA small take authorization) or may not apply to the specific type of action being considered.[e] In the BA, the acting federal agency is responsible for outlining in detail the potential impacts of the proposed activity on listed species. The agencies then review the BA to determine whether an informal or formal Section 7 Consultation is required.

Section 7 Consultations and Jeopardy Determinations[54]

If the potential impacts of the activity are not likely to adversely affect listed species, then only an informal Consultation is required. However, if the potential impacts are likely to adversely affect listed species, then a formal Consultation is required and the agencies prepare a Biological Opinion (Opinion) to assess whether the action is likely to jeopardize the continued existence of listed species, or destroy or adversely modify designated critical habitat. The Opinion determines whether there is "jeopardy" or "no jeopardy." A non-jeopardy Opinion establishes non-binding "reasonable and prudent measures" to mitigate the impacts of the proposed action, and sets forth other requirements (e.g. reporting). On the other hand, if the Consultation finds there is "jeopardy," the Opinion must contain "reasonable and prudent alternatives" to the proposed action that mitigate impacts to listed species to the point that the activity does not pose jeopardy to the species.

[e] The Biological Assessment requirement only applies to "major construction activities" as defined in 50 CFR sec. 402.02.

Incidental Take Statements[55]

After the Section 7 Consultation and resulting Biological Opinion are completed and a "no jeopardy" finding has been made, the agencies must grant the acting federal agency an Incidental Take Statements (ITSs) for any federal activity (including permitting activities for other, non-federal actions) that is likely to incidentally take listed marine mammals. The ITS can only be applied for after the federal action in question has received an authorization under the MMPA.

Section 10 Incidental Taking Authorizations

Incidental taking authorizations may also be granted for private citizens under Section 10 of the ESA. However, these authorizations are generally unnecessary for marine mammals. By virtue of applying for a small take authorization under the MMPA, private citizen applicants generate a federal action that triggers a Section 7 Consultation and obviates the need to apply for authorization under Section 10.

d. State Regulatory Procedures: California Example[56]

Under the Coastal Zone Management Act, coastal states have authority to regulate activities that may affect resources within state waters. We will discuss the approach taken in California, where these authorities are carried out by multiple agencies.

State Lands Commission (SLC)

The SLC is the owner of tide and submerged lands in California, usually out to three miles. It may issue leases and permits within or over these tidal and submerged lands in a similar way to how the federal government does further out for the OCS.

Department of Fish & Game (DFG)

Responsible for regulating the use of explosives in Californian waters, the DFG also designates and manages Marine Protected Areas (MPAs). Its Office of Oil Spill Prevention and Response (OOSPR) deals with rules and regulations pertaining to oil spills. It should be noted that not all states manage MPAs and marine sanctuaries through the CZMA; some are federally managed.

California Coastal Commission (CCC)

The CCC regulates uses of coastal resources under coastal development permits and the federal consistency authority under the CZMA. They are also responsible for the administration of the California Coastal Act (CCA), which requires protection of marine resources, sensitive habitat, commercial and recreational fishing, general recreation, and the California Coastal Management Program (CCMP; under the CZMA). Accordingly, they utilize the best available scientific information for staff reports as one of the bases for decisions. Where there is insufficient scientific information available, the CCC usually takes a precautionary approach in seeking to protect coastal resources. The CCC does not develop scientific information or engage in research, although they often recognize that current knowledge is inadequate to inform their policy decisions.

Example of State Permit for Private Development in California The 1997 Mobil Oil Company Pier and Wharf Decommission in Ventura required a coastal development permit as it involved the use of explosives. The issue of concern was the impacts of the resulting noise on marine mammals, among other species. Accordingly, a permit for the activity was granted, but it included conditions for monitoring and avoiding marine mammals. These conditions included a safety zone for marine mammals that must be adjusted in real-time based on actual field measurements. This verification determined that the original model-derived size of the safety zone needed to be increased 2-3 times to effectively reduce the acoustic impacts on marine mammals.

4. Potential alternatives to command and control regulations, including non-regulatory options

[This should include brief discussion of performance-based models (*e.g.*, strategic initiatives for "sustainable" business practices), procedural standards or guidelines (*e.g.*, ISO 14001), voluntary compliance models (*e.g.*, certification programs), and other management tools.]

5. Costs of Permitting

Costs Related to a US Fish and Wildlife Service Take Authorization[57]

[This information was submitted by the USFWS. The Subcommittee should discuss its inclusion and possible supplementation.]

The fee for an application for a new research permit is $100, with $25 for renewals or amendments, unless the applicant is exempt. The initial application for an LOA for activities in Alaska also requires about 200 hours of labor investment, with an additional 28 hours for completion of paperwork, monitoring and reporting. There are also processing costs for applications for scientific research permits to U.S. Fish and Wildlife Service of around $700-900, including fees and labor, based on an average government wage of $30/hr. There is an additional cost of $100 per permit if the species is listed under the ESA.

E. Mitigation Tools

[The suggestion to categorize/rearrange these tools has not yet been addressed.]

1. Existing and Potential Methods

This section provides an overview of the mitigation tools currently in use or available for addressing impacts of anthropogenic sound on marine mammals. They are often used in combination and are not mutually exclusive. While the agencies may require that the recipient of an IHA or small take authorization conduct research, and typically require that the recipient submit reports, these are not strictly mitigation tools and are thus not included in this section. They are discussed elsewhere in this report (see sections on Information and Research, and Enforcement, Compliance and Reporting).

Seasonal Restrictions

Description and Purpose

The agencies may impose limits (including bans) on an activity during biologically important periods, such as during annual migrations or breeding. The times associated with such restrictions could be fixed according to calendar dates, or associated with biological activity, such as arrival at a particular location.

Limitations, Effectiveness and Potential Applications

Some marine mammals, including ESA listed species such as the humpback whale and right whale, migrate each year between polar feeding areas and tropical breeding grounds. Seasonal restrictions may be very useful in limiting impacts on such species, but there are limitations to the application of this mitigation strategy. Animals (from the species linked to the restriction and others) may be affected by an activity during seasons other than those when restrictions are applied. Consequently off-season operations can affect the ecosystem in ways that indirectly impact the target species, such as through affecting prey availability. Furthermore, fixed seasons may lead to a mismatch with the actual biological season, such as early migration arrival or late departure. Management tools to deal with this can require that monitors be on site to determine the presence or absence of the animals and adjust the restrictions accordingly.

In some cases, the flexible management framework required to handle biologically controlled seasonal restrictions can make them difficult to implement and thus unappealing to managers and the regulated communities. Ensuring that the restrictions are based on actual migrations rather than calendar dates is necessary, but difficult to accomplish in the long range planning of surveys and other acoustic activities.

Geographic Restrictions

Description and Purpose

Geographic restrictions place spatial limits on an activity in a specified geographic region. The area could be selected for various reasons. It may be a biologically important habitat, such as a critical habitat as defined under the ESA; it may comprise the entire habitat of a particularly sensitive species, such as the Gulf of California for the vaquita; or it may contain geographic features that result in a high likelihood of impacts occurring, such as shallow water, or deep canyons. Restrictions in these areas may include limited access, moratorium on an/all anthropogenic sound activity, or rerouting. Authorizations may require that new sites be surveyed in advance of an activity to determine if a geographic restriction is appropriate. The sizes of restricted areas can vary greatly, and can be quite large. For example, the U.S. Fish and Wildlife Service restricts access within 22 km of Pacific walrus haul out sites in Bristol Bay.

Limitations, Effectiveness and Potential Applications

Acoustic impacts on all marine life can be reduced by simply avoiding areas were it is abundant. In some cases, however, geographical protections may be difficult to apply. Many marine mammal species are wide ranging, making it difficult in some cases to delineate a specific region in which protections are needed. For example, beaked whales are found in virtually all ice-free deep-water habitats,[58] although there are some North Atlantic beaked whale species that are often found in certain habitats, such as underwater canyons, shelf edges, and seamounts.[59] In addition, it is frequently difficult to determine (and often unknown) what habitats are of critical biological importance to particular marine mammal populations, in part because very little is known at the level of biological populations; in such cases, targeting activities in areas known to carry low abundance of marine mammals and vulnerable species may be more effective (*i.e.*, Geographical Selection). In any case, habitat parameters in the marine environment are highly variable.[60]

It should also be noted that, since many types of anthropogenic noise travel long distances underwater (see Synthesis on Current Knowledge Report), large areas of exclusion may be necessary to protect particularly vulnerable habitat from these sources. Despite the limitations, geographic restrictions are possible and can be effective, as recently illustrated when commercial shipping lanes were rerouted around locations known to be critical to right whales (done to reduce ship strikes, in this case).

Dynamic Management Areas (DMAs) including Safety Zones

Description and Purpose

A dynamic management area (DMA) is essentially a temporary set of restrictions that come into action (or are "triggered") when certain conditions are met.[61] They can be applied to a pre-specified geographical area, but are generally centered around the presence of an animal or their home. Trigger conditions include, the presence of one or more animals in an area, the amount of time that the animals remain in the area[62], or the presence of a denning mother.[f] For example, DMAs are used to limit disturbance, acoustic and otherwise, of female polar bears with their young cubs in Alaska, where restrictions are placed for 1 mile around occupied dens during denning season.[g] Similar DMAs have also been proposed for seismic surveys off the coast of Canada, such that track lines would be adjusted to avoid areas of greatest marine mammal abundance based on aerial surveys at the beginning of each run.[63]

Safety zones (also called exclusion zones) are a particular kind of DMA, centered not around an animal, but instead around a sound source. A safety zone is a specified range from the source (generally based on a received sound pressure level) that must be free of marine mammals before an activity can commence (often referred to as determining an "all clear") and/or must remain free of marine mammals during an activity. If a marine mammal enters a safety zone after during the activity, a shut down is usually initiated.

The size of safety zones can be determined using propagation models or through field data or verification. As part of the research conditions, some permits require that the modeled safety zone be verified through a field test prior to the project, others state that the model can be verified during the project and the zone adjusted accordingly for the remainder. Some permits do not require verification at all. In any case, field verification does not actually assess the effectiveness of a safety zone.

Limitations, Effectiveness and Potential Applications

DMAs do afford some measure of protection for marine mammals and other target species, but their effectiveness is limited in two significant respects. First, their effectiveness depends on one's ability to determine the position of animals in an area. For example, Safety zones require that a marine mammal is detected as it enters the zone, as opposed to once it is already inside and already exposed to potentially dangerous levels of sound. Observers undertaking visual surveys, PAM, AAM, or using other remote sensing techniques would therefore be required. Even with these methods, it is unlikely that 100% of all marine mammals will be detected (see *Limitations* for each tool). Even with near-perfect detection of a highly vocal target species, such as the sperm whale, the presence of other sensitive marine mammals, such as beaked whales, might be missed. Possibly the most effective application of this tool to date is found in the case of denning polar bears as the animals are generally stationary during this period and do not

[f] Citation needed

[g] Citation needed

submerge themselves. However, there are other issues regarding their detection (see Non-Acoustic Remote Sensing section) and no formal evaluation of the effectiveness of the 1-mile exclusion zone has been carried out, although there is no record of any den abandonment with this zone in effect.[h]

There continue to be discussions among scientists regarding the appropriate size of a safety zone, due to difficulties determining both the predicted received levels of sound and safe exposure levels. Similarly, the propagation models upon which the size of safety zones are based may not reflect the actual propagation of particular sound sources. For example, measurements of received levels from the seismic sources used by the R/V *Maurice Ewing* were found to be higher than suggested by models in shallow (≈30 m) water, with indications that they may be lower than predicted by models in deep (≈3200 m) water, although data were limited for the latter.[64] The actual received levels were also significantly higher than the predicted in the case of the decommissioning of the Mobil Pier mentioned earlier in the California example.[i] Finally, and perhaps most importantly, safety zones represent a very small area of the total area ensonified and thus do not benefit marine mammals beyond their limits. Thus safety zones may be appropriate only when paired with other methods of mitigation.

Operational Restrictions

Description and Purpose

The potential and actual impacts of anthropogenic sound may be mitigated through operational restrictions, which are limits placed on specified aspects of a sound-producing activity's operations. Examples of operational restrictions include speed limits on vessels, which help reduce sound production through a reduction in propeller cavitation and engine noise, and sonar or seismic airgun power limits, which involve a reduction in the source level used. Such restrictions involve in-situ changes, such as lowering the power of an array of airguns, or ceasing airgun use at the end of a survey line.[65]

Limitations, Effectiveness and Potential Applications

Some operational restrictions have been successfully applied, but the use of such measures is not widespread, nor has their effectiveness been thoroughly tested. Some operational restrictions have been put in place to protect marine mammals from other anthropogenic impacts (*e.g.*, speed zones in manatee habitat to prevent collisions). The success of these measures depends on the context of their application. For example, it has been noted that the threat of increasing numbers of vessels to marine mammals arises from the related effects of boat approaches and sound production, with vessel sounds disturbing the animals, or disrupting or masking their acoustic communications.[66] The level of sound and the probability of disturbance decline with reduced speeds, and it may be possible to determine geographic areas where reduced speed zones for vessels may at certain times be practicable for the vessels and beneficial for the whales, addressing both economic and safety concerns.[67]

There is, however, considerable discussion surrounding speed restrictions on vessels (commercial or recreational). Speed limits have to date generally been implemented to reduce ship strikes, but while slower speeds do generally produce less engine noise, the effectiveness of

[h] Citation Needed
[i] Citation Needed - SW

speed limits at reducing noise is uncertain partly due to enforcement issues, and any resulting inefficient restrictions may generate economic impacts for commercial vessel users.[68] However, currently researchers are working to examine the sound levels produced by recreational boats and their impact on manatee behavior).[j]

Marine Mammal Observers

Description and Purpose

Marine mammal observers are individuals (typically biologists or crew members[k]) required to conduct visual surveys of marine mammals (*i.e.*, watching for their presence or behavior) for various reasons including, but not limited to: maintaining marine mammal-free safety zones; monitoring for avoidance or take behaviors; fulfilling research conditions; and avoiding potentially fatal interactions. The latter may not be for the benefit of the animals alone as interaction can also be fatal for humans (*i.e.,* human-polar bears interactions during arctic activities).

Observers are usually used as part of shipboard and aerial surveys, but they can also be land-based for sea surveys, or for monitoring coastlines for strandings. Research requirements for observers may include monitoring, obtaining pre-activity numbers and distribution of marine mammals, or completing a post-activity site survey looking for evidence of takes. Horizontal distance to the sighted animal is most often estimated using reticulated binoculars or calculated using an inclinometer during aerial surveys. Regardless of research requirements, trained observers can provide important information about the density, approximate location and patterns of disbursement of the species sighted.

Specialist observers may be required, such as native Alaskan observers for activities in the waters around that state due to their traditional knowledge and experience. Specialist observers are not limited to humans, as trained dogs have been used to sniff out seal lairs, polar bear dens, etc. for compliance with geographic restrictions.

Limitations, Effectiveness and Potential Applications

The faults inherent in visual observation are well known to marine biologists. Visual observations are generally limited to hours of daylight.[69] Although some night-vision gear is available, it cannot fully compensate for the lack of sunlight and does come at a cost.[70] Deteriorating atmospheric conditions (*i.e*., fog) and/or sea state conditions also reduce detection rates.[71] As a result it can be hard to define at what point surveys become ineffective, and also which plan of action should ensue when that point is reached (*e.g.,* should the project be delayed until conditions improve?). Visual detection is also limited by the fact that it can only be achieved at or very near the surface.[72] As a result, many cryptic species, that spend very little time at the surface, such as the deep diving beaked whales, are hard to spot in ideal conditions, with the probability of detection dropping rapidly as conditions deteriorate (to an average detection rate of only 1-2 % of animals in the case of beaked whales).[73] However, sighting rates of experienced observers are around twice as high as less experienced observers.[74] Additionally, observations made by those who have not received adequate training can be unreliable.[75]

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[j] See permits issued by FWS – CC to provide details

[k] NOTE – the terms “Trained Crew Member” and “Marine Mammal Scientist” or “Biologist” may need additional definitions.

Accordingly, Guidelines for Minimising Acoustic Disturbance to Marine Mammals developed by the U.K. Joint Nature Conservation Committee (JNCC) suggested that the most qualified and experienced personnel should be sought after to act as marine mammal observers.[76] Observer fatigue leads to a reduction of efficiency and thus watches need to be limited to reasonable lengths (*i.e*., no longer than 4 hours).[77] Additionally, effectiveness is also related to the number of observers used at any given time.[1] As a result, the use of observers can be expensive, as a team of 7 to 12 or more observers might be required for a particular activity that operates around the clock. An additional factor is that not all data collection and reporting of observations currently follows consistent formats, restricting their application and making comparisons and evaluations difficult.

Additionally, aerial surveys are limited by flight restrictions, and to near-shore areas for practical reasons. They are most productive when marine mammals are concentrated in time, space, or both (i.e. in a well-defined migration corridor[78]) and they can provide valuable information as to the location and direction of marine mammals. Other issues arise for shipboard surveys regarding limited berth space (especially if the observers are deployed on industry vessels, i.e. seismic survey ships).[79]

Although a formal assessment of reliability and consistency has not been made, the use of trained dogs to detect polar bear dens appears to be an effective technique.[80] However, dogs may react to old bears scents from abandoned dens, giving false positive results that would in turn produce undue restrictions on activities and the level of disturbance generated by the presence of the human-dog teams is not known.[81]

Observation Through Non-Acoustic Remote Sensing

Description and Purpose

Under certain conditions, it may be necessary, or required, to employ some technological methods of detection and observation. For example, a polar bear heat signal can be detected using Forward-Looking Infrared Radar (FLIR) during the arctic winter when visual survey methods are not possible. Other techniques include the use of deployed time-lapse video cameras, radar, hyper-spectral imagery, satellite imagery and Light Detection and Ranging (LIDAR).

Limitations, Effectiveness and Potential Applications

Even technologically assisted observations are dependent upon the weather. For example, one study assessed the effectiveness of an aircraft mounted with modern FLIR imagery equipment in the detection of polar bear dens.[82] Detection rates of nearly 90% were achieved in ideal conditions, but airborne moisture (e.g. snow, fog) and lower air temperatures (closer to dew-point) greatly reduced detection rates. Furthermore, the presence of any direct sunlight on the snow in the area being surveyed prevented detections, and sea ice FLIR surveys were subject to too many competing heat signatures to be effective.[83] The latter was due to the variable nature of the environment, which limits the capacity of FLIR to monitor marine mammals that have lairs exclusively in the sea ice, such as ringed seals.

[1] Citation Needed - SW

Like visual surveys, however, these methods still require the animals to be at or near the surface for detection, with LIDAR being one of the more penetrating techniques, able to image some subsurface objects to maximum depths of around 30 m, depending on visibility.[84] The use of some other technologies is limited due to the need for continual access. For example, deployed time-lapse video cameras to remotely monitor activity at polar bear dens, require periodic visits by scientists because of current video and battery life limitations.[85] Additionally, not all remote sensing techniques allow real-time monitoring.

Flight Restrictions

Description and Purpose

Flight restrictions merit a separate mention because they are often overlooked in the protection of marine mammals. Rocket launches, helicopter flights, *aerial surveys* and other aircraft activities are often subjected to a variety of flight restrictions to address potential impacts on marine mammals. For example pilots may be required to maintain a minimum altitude (*i.e*., 305 m or 1,000 ft) and/or a maximum speed (*i.e*., 220 kph or 120 knts). Other possible flight restrictions include geographic, seasonal or temporal restrictions.

Temporal Restrictions

Description and Purpose

The agencies may impose temporal restrictions, limiting an activity at specific times of the day. Often this is a ban on the activity from 30 minutes before sunset to 30 minutes after sunrise, primarily because visual surveys (by observers) are most effective during daylight. Other reasons for such restrictions might include biologically important periods of the day that might involve particularly sensitive behaviors, such as resting or milling, which in many cetaceans is easily disrupted by ship or aircraft noise.[86] Determining the beginning of such periods may require an observer to identify these behaviors. Another type of temporal restriction may be tied to a safety zone, requiring that it should be all clear of marine mammals for 30 minutes prior to activity commencement or restarting after a shut or stand down.

Limitations, Effectiveness and Potential Applications

Times that are important to one species may conflict with those important to another. Furthermore, there is no guarantee that animals outside the restricted area, or within the area at an unrestricted time, will not be affected.

Use of Sound (Dry Firing, Ramp Ups, Acoustic Deterrent and Harassment Devices)

Description and Purpose

Sound may be introduced at reduced levels prior to activity or between episodic activity to deter marine mammals from approaching a potentially damaging sound source. Such measures include dry firing, ramp ups, acoustic deterrent devices (ADDs), and acoustic harassment devices (AHDs). Dry firing pile driving hammers prior to operating at full capacity involves raising and dropping the hammer with no compression of the pistons. This action produces approximately 50 percent of the maximum in-air noise level, and is designed to allow nearby (hauled out) pinnipeds to move from the area and should expose fewer animals to loud sounds both underwater and above water.

Similar to dry firing, a ramp up, involves the gradual intensification of a sound source, such as an airgun array firing at a reduced level, working up to full strength before the beginning of a seismic survey. Airguns can also be used in a similar way, for example if some kind of mechanical problem requires that a seismic survey be suspended, the project could leave a single airgun firing at a reduced level (*i.e.*, 160 dB re: 1 µPa at 1m) to avoid requiring a full all clear prior to resumption.

In contrast, ADDs are, specific devices designed to produce a variety of sounds (generally pure tones of 145 dB re: 1 µPa at 1m[m]) in an effort to deter marine mammals from approaching fishing nets, docks, or moorings. AHDs are louder sources (>180 dB re: 1 µPa at 1m) than ADDs (<150 dB re: 1 µPa at 1m) and are typically used to protect investment in deployed gear, such as aquaculture pens, from marine mammals, rather than to protect marine mammals. However, they could theoretically also be used to prevent marine mammals from approaching a more dangerous source, although this, like most other techniques, would require testing.

Limitations, Effectiveness and Potential Applications

The use of any sound in deterring the approach of marine mammals may pose its own acoustic danger to the animals; potentially producing many of the detrimental effects they are designed to mitigate. The best way to determine their effectiveness is through extensive testing of each method, although there are many situations, particularly in the case of acoustic alarms, where the use of sound should be strongly discouraged.[87]

Dry firing and ramp ups are the most frequently used techniques by those who are introducing loud sounds into the marine environment. Also, dry firing and ramp ups are based on the assumption that animals will detect the lower level sounds and move away from the source.[88] As this assumption is untested, there is the potential for lower level sounds to stimulate curiosity or trigger another mechanism that could draw them closer instead.[89] It is known that this is the case in some other species, for example it has been shown that some sharks are attracted by certain low-frequency sound.[90] Another assumption is that once a sound is at full strength, a moving source will act like it is continuously ramping up as it approaches marine mammals, becoming louder as it gets closer.[91] This may not be the case, and has not been systematically studied. Ramp ups are not viable for military sonar as it would lead to loss of tactical advantage, although they may be useful for mitigation in some practice maneuvers and/or equipment testing.

The effectiveness of a ramp up procedure conducted with a seismic survey has been assessed, but the results were not clear.[92] Some cetaceans swam away during the ramp up, although pilot whales did not appear to follow this pattern. Some dolphins even engaged in bow riding during ramp ups, possibly limiting their ability to leave the area before sound levels reach dangerous levels. Halting the ship until the dolphins disperse before restarting the ramp up could address this, although additional sound will be placed into the environment, the project will be subject to further delays, and there is no guarantee that the bow-riders will not return. One study suggested that, as ramp ups are designed to reduce the impact on undetected animals, the presence of bow-riding dolphins, well within any safety zone, should trigger a delay in the seismic survey, if not a full shut or stand down.[93] As ramp ups are introducing more sound into the environment (and have costs for industry), their length should be limited appropriately. The JNCC Guidelines limit

[m] Citation needed - MJ

ramp ups (referred to as 'soft starts') to no more than 40 minutes.[94] Such restrictions are crucial if the survey area is of particular importance to a species, such as for feeding, as marine mammals may slowly accommodate to increasing sound levels to and beyond harmful levels.[95] However, it should be noted that these restrictions can only reduce the possibility of habituation at best, although this is once again untested, and will not completely eliminate the problem.

Experimental difficulties (*e.g.*, relying on fishermen for data) have plagued assessments of effectiveness for acoustic deterrent and harassment devices (ADDs and AHDs), and many promising studies have not been long enough to investigate habituation.[96] Consequently, many of the mixed reports of success or failure are often based largely on trial and error and are little more than anecdotal.[97] Recent tests of alarm signals intended to reduce right whale ship strikes have been found to incite inappropriate responses (*i.e.,* coming to the surface), likely making the whales more susceptible to boat strikes, while boat noise, at audible levels, appeared to elicit no response at all.[98] In general, further study is needed to determine where ADDs and AHDs might be used effectively to reduce the impacts of anthropogenic sound.

Finally, the extent to which any marine mammal associates a particular acoustic signal with the presence of danger is not known. For example, large whales, which often escape entanglement in fishing gear, may be able to learn an association if a consistent alarm type is used on the gear, but smaller cetaceans generally do not survive net collisions on most occasions and therefore would not learn to avoid them.[99]

Engineering or Mechanical Modifications

Description and Purpose

Technological improvements or modifications to the design of equipment or techniques may enable those producing sound to reduce the intensity, or alter other hazardous characteristic, of sounds they introduce, while still allowing intentionally produced signals to accomplish their intended purposes. For example, some ship-quieting technologies may have benefits for almost all concerned (with the possible exception of ship-struck whales) because they improve engine efficiency and/or reduce disturbance to humans. One of the most promising ship-quieting technologies is advanced propeller design to reduce or eliminate cavitation (the formation of tiny air bubbles), which limits efficiency and increases fuel usage while also generating noise. Thus, the potential exists for the shipping industry to also benefit through the improved fuel efficiency resulting from the quieter propeller designs.

[More details could be added when the Shipping Symposium report is released]

Technological advances may also be available to reduce the sound levels produced by seismic surveys. For example, it is possible to design surface-towed systems that produce long swept frequency pulses. It may also be possible to develop an effective mobile sea floor source with surface trawled receivers, or even a fully autonomous sea floor seismic survey vehicle. It may also be possible to alter the characteristics of sound sources in order to reduce their potential biological impact. For example, certain signals used for human purposes could be adjusted to operate at different frequencies, with narrower beams, over shorter time scales, or to incorporate alternative characteristics or different waveforms, to which marine mammals are less susceptible. Some efforts are already underway, with the Dutch and Norwegian navies experimenting with techniques to modify the signal of some of their active sonars. For seismic surveys, this may take the form of the development of "suppressor" devices for reducing superfluous high frequency energy, or increases in the directionality of sources; a modification that has been recommended in other countries.[100] Another way to lower signal levels in seismic surveys is through increases in the number or capacity of hydrophones at the receiving end of the operation, and improving already sophisticated signal-processing techniques.

Limitations, Effectiveness and Potential Applications

In general, technological modification is an approach to reducing the impacts of a number of sound sources with much potential, deserving further investigation. Indeed, some of the advances described above represent ongoing improvements. For example, the number of hydrophones used during seismic operations and signal processing techniques for all projects are continually improving. Other envisioned technologies would require revolutionary innovation and may be not be available for some time. For example, airguns, which produce sound pneumatically, do not function efficiently at depth due to the large pressures, so they cannot be deployed at or near the sea floor. There is also only a trivial reduction in signal level when placing a source on the ocean floor, because the losses due to propagation through the water column are small compared with the attenuation that occurs in the earth's crust. Furthermore, any autonomous source devices are impractical because of the amounts of energy required to operate them and the current capacity of batteries.

Reducing the output of a source, or restricting its propagation in any significant way, is almost certain to reduce its impacts. The effectiveness of other changes may be less certain, however. To change the characteristics of a sound to make it less damaging, it is vitally important to determine which characteristics are responsible for any given problem.[101] For example, the surface-towed systems that produce long swept frequency pulses for oil and gas exploration would trade a reduction in source level for substantially increased signal duration, which could result in more masking effects. It has been suggested that extensive field-testing or research in the form of Controlled Exposure Experiments (CEEs) would be required to answer these questions.[102] However, the use of CEEs is controversial as they deliberately expose marine mammals to sounds, and there is a limited amount of information currently available on how sound might be damaging to marine mammals.[103] There may also be difficulties in developing ship-quieting technologies, as they will need to be tailored differently for the various types of vessels.

Shut Down or **Stand Down**

Description and Purpose

This tool is usually combined with a safety zone and/or observers, and involves the suspension of an activity until the marine mammal has left the safety zone or normal behavior has been restored. Permits may then require a temporal restriction, or a renewed "all clear" before resumption of the activity. Shut downs can also be required at a point where observers are no longer able to reliably detect marine mammals within a safety zone (*i.e.,* sea states above Beaufort 3). Some authorizations may require that the integrity of a safety zone be re-established (through aerial or shipboard surveys, etc.) before an activity can recommence.

Limitations, Effectiveness and Potential Applications

See those discussed in the sections on Observers, PAM, AAM and Safety Zones.

Passive Acoustic Monitoring (PAM)

Description and Purpose

In PAM, observers use hydrophones, or remote or autonomous recording devices (ARDs), to determine if marine mammals are present through the detection of vocalizations or particular sound-producing behaviors. This may consequently trigger safety zone or seasonal type restrictions. A lack of such detections may also be required as part of an all-clear determination.

Limitations, Effectiveness and Potential Applications

It is unlikely that PAM will ever provide a stand-alone solution, but it is likely to become an extremely important component of an integrated monitoring and observation system. Accordingly, the JNCC views PAM as the only available mitigation method that, at its current stage of development, will increase detection rates (of visual surveys) prior to a ramp up while having no adverse effect on marine mammals of its own.[104] At this time, PAM is perhaps most useful as a supplement to visual survey efforts in this way, especially for some deep diving species[105] as it is still developing and is currently subject to a range of limitations, not least of which is a high false positive rate (around 50%).[n] Furthermore, all PAM methods require a vocalizing marine mammal to work. Unfortunately, while some species vocalize almost continuously underwater (*e.g.*, sperm whales), others do not. Additionally, the sound production of many marine mammals is unknown, and species identification based on vocalizations can often be very difficult.[106]

There are also technical limitations, such as the fact that stationary hydrophones or ARDs are not particularly useful for monitoring a highly mobile sound source, while towed hydrophone arrays must deal with constant ship noise (unless done from a sailboat). Either method requires at least 2 and preferably 3 hydrophones to determine the location of a marine mammal,[107] and PAM is not as accurate as visual surveys for determining distances.[108] Furthermore, ARDs collect large amounts of data (as can human-intense methods) that generally require automatic detection algorithms, which can never fully account for all biological variation and are subject to error. Such algorithms can only be produced if scientists have confirmed examples of signals produced by the target species.[109] It may be possible to connect ARDs to buoys that relay data via satellite, by VHF, or using cellular phone frequencies. This would be expensive, especially given the amount of data and the need for a continuous connection. Regardless, data interpretation would still be required, which could be done, like all PAMs, in near real-time using algorithms for a few better-known species (*i.e.*, the sperm whale). Marine mammals about which less is known would require human interpretation, a much more drawn out process if spectral analyses are required. Marine mammal detection by humans using PAM also improves immeasurably when the observer knows what to listen for prior to surveying.[110]

Despite these limitations, PAM has much potential for use in the future and continues to be developed. The systems currently being tested are continuously improving and providing much more data than earlier efforts. Furthermore, the development of new ocean observing systems (*e.g.,)*may provide infrastructure (*e.g.*, networks of seafloor cables in some locations, broadband

[n] *Discussed at October Meeting – does anyone have a reference*?

hydrophones at observatory stations) to assist in the application of PAM on a global scale. For example, the Defense Threat Reduction Agency (DTRA) arrays in the Indian Ocean have shown that Antarctic blue whales migrate much further north in the Indian Ocean (into the tropics in fact) than ever before known.

Active Acoustic Monitoring (AAM)

Description and Purpose

AAM involves the use of sonar before and/or during operations to find and track marine mammals, and is generally limited to "incidental monitoring" when the activity itself involves active sonar, rather than introducing additional sound into the marine environment for the purposes of monitoring. However, there have been some recent efforts to develop "whale-finding" sonar.[111]

Limitations, Effectiveness and Potential Applications

Modern military and commercial/civilian sonars have been developed over decades to serve specific functions (*i.e.*, to detect specific types of targets), and thus there are many technological options available for further developing AAM methods for marine mammal detection. Additionally, a 30 kHz sonar system (designed by Scientific Solutions, Inc.) was successful in tracking gray whales in shallow water off the California coast in its first deployment last year. However, target identification remains a problem for AAM, possibly requiring multi-frequency systems to solve, as only target strength (a proxy for target size) is currently identified for any detected object. Consequently, high detection rates are often accompanied by high rates of false detection, and a reduction in false positives will go hand-in-hand with a reduced rate of correct detection.[112] The receiver-operating curve for marine mammals has only limited data to determine the best balance and thus much performance testing would be needed to evaluate the effectiveness of this option.[113] Field-testing which has been done has shown AAM to be generally problematic and not as effective at detecting smaller species. Additional problems arise in very shallow waters, so the ability of any active sonar to detect manatees is also thought to be lacking. Furthermore, as AAM requires emitting sound into the marine environment, a review of potential impacts to and benefits for marine mammals is needed before AAM, specifically for the detection of marine mammals, is utilized.[114] However, there are many examples of phenomena that have beneficial uses at low levels, but damaging at higher exposures (*e.g.*, X-rays). There is not enough currently known to discount active sonar as a potentially useful mitigation tool. Relative to the magnitude of the problem, only a trivially small amount of research has been done on AAM. It should again be noted that, like PAM, this technique will not be a single stand-alone solution, but could play a role in an integrated detection system.

Sound Attenuation

Description and Purpose

Bubble curtains, blasting mats, dampening screens and similar devices and techniques are used for limiting (attenuating) the amount of acoustic energy leaving a sound source. These mitigation tools are primarily employed around stationary sources, such as pile drivers and explosions.

Limitations, Effectiveness and Potential Applications

Although use of a bubble curtain does reduce the level of sound radiated from a source, it does not appear to eliminate all responses in marine mammals. One study found that bubble curtains can reduce broadband (*e.g.*, 100 Hz to 25.6 kHz) sound intensities from pile driving by 3-5 dB on average, with the greatest reduction (10-20 dB or more) evident in the 400 Hz to 6.4 kHz range.[115] However, during the same study the abundance of humpbacked dolphins in the area was lower immediately after pile driving mitigated by bubble curtains than the abundance before or during the activity. Furthermore, the dolphins' travel speeds were higher during the activity. Thus questions remain about the effectiveness of sound attenuation as a mitigation tool.

Training and Education

Description and Purpose

Training and education may be required as part of marine mammal permits, and generally involve requirements for training of all the members of a crew in various ways. For example, they may need to recognize a particularly sensitive species, or simply to be aware of the impacts that their activity has on marine mammals so that they can act appropriately around marine mammals and understand the reasons behind any limitations placed upon their actions.

It may also be relevant to require public education, especially in areas where there are many public sources of noise present in marine mammal habitat (such as recreational boating in Florida's shallow, inshore waters). Such education could lead to a reduction in the amount of from dispersed sources in sensitive areas.

Reduction In Activities

Description and Purpose

Reducing exposure through reducing the amount of time during which a sound is produced can mitigate potential impacts. This can generally be achieved by increasing efficiency. Examples include eliminating unnecessary underwater communication for submarines; avoiding duplication of a seismic survey by having companies share data or employ a common surveyor; maximizing the coverage of survey lines to reduce the number of passes; avoiding duplication of research efforts when replication is no longer required, perhaps through the more complete publication of results; using simulations to replace some navy sonar exercises; and attempting to fill every cargo ship to capacity for every journey to reduce the number of trips.

Limitations, Effectiveness and Potential Applications

This can potentially be very beneficial to all as increased efficiency results in lower cost for any particular activity. As a result, the applications are almost as diverse as are the various human activities on or in the ocean. However, there are many logistical problems that need to be addressed with each case being different and thus requiring separate examination. Examples of practical limitations include: defining "unnecessary communication"; data sharing issues between competitive companies; determining the most efficient survey coverage over irregular ocean topography, around restricted habitats, and other obstacles; limited research funding and resources often resulting in under-analyzed data sets and consequently less information published; an acknowledged need for field testing navy sonar and crew; competition between companies that would complicate attempts and unreasonable delays arising from waiting for enough cargo to fill the ship that would drive costs up and destroy the economic benefits.

Many tens of millions of dollars are invested each year by the seismic industry in the development of improved seismic data acquisition systems.[o] These efforts have resulted in improvements in imaging the deep earth without the need for increasing source levels, as well as reduction in the number of track miles that have to be shot.

Geographical Selection

Description and Purpose

This tool differs from geographical restrictions as it involves identifying low-risk areas and assigning them to be used for certain activities, instead of avoiding high-risk areas.

Limitations, Effectiveness and Potential Applications

Low-risk areas need to be identified. Some activities are linked to particular sites, as shipping is to ports, and so the potential applications for geographical selection are limited to those activities that are more flexible. Such activities are not common and are largely limited to Naval exercises and some types of research. However, the assignment of such actions to low-risk areas could reduce the impacts of these actions upon marine mammals.

2. Costs of Mitigation

The costs of mitigation vary from one tool to another, from one project to another, and even from one viewpoint to another, making them hard to determine precisely. Furthermore, not all costs are economic, as there are also missed opportunity, environmental, and social costs to consider. Missed opportunity costs may result from restrictions, which inhibit the development and use of a resource and generally arise when access to a particular area is permanently limited or prohibited (*i.e.*, geographical restrictions). Environmental costs may be incurred when mitigation efforts are not undertaken, not correctly implemented or are simply not effective at conserving the species.

Comparisons among the costs of implementing various mitigation tools is desirable, but comprehensive data to aid in such comparison is not readily available. Some of the relatively less expensive tools involve paying for observers and their equipment. However, observers may still constitute a sizable proportion of a small research budget, with costs increasing dramatically if dedicated vessels or aircraft are required. High-tech observation equipment, such as PAM, AAM, and those involved in other remote sensing techniques also push up observation costs, but can vary greatly from situation to situation. For example PAM using a hydrophone array towed behind a seismic survey ship already geared for such an operation is simple and inexpensive. However, it can be expensive for other projects, especially if additional ship time is required. In these cases ***ARDs*** may provide a cheaper option, requiring only brief periods of ship and personnel time for deployment, recovery and data analysis, but they (currently) do not work in real time, and may have a limited recording frequency due to memory constraints.

Larger still costs are generally incurred with the use of rerouting and other seasonal restrictions. These can lengthen distances traveled due to circumnavigation or the generation of inefficient travel, such as occurs when a seismic survey ship must later return to an en-route site because

[o] Citation needed - BT

they are not able to survey during that particular time of year. Similar costs can also be generated by operational restrictions, especially ***speed restrictions***.

A recent study evaluated the financial costs of establishing a 10-knot ***speed restrictions*** on large vessel traffic into and out of most U.S. East Coast ports along the migration routes of right whales for a distance of 25 nautical miles during the migration season (60 days).[116] Ranging from \$0.3 million for Portland, ME and Wilmington, NC to \$4.8 million for the Port of New York and New Jersey, the average cost of such restrictions for effected ports was conservatively estimated at \$1.3 million/year. The estimated total cost of such restrictions for the entire area affected was around \$16 million, although the actual figure is likely to be lower (approximately \$10 million) due to the various conservative assumptions made in calculation (*e.g.*, high operating costs, delay penalties and normal operating speeds). This study covered only a tiny fraction of the industry's activities, and cost sharing could be employed in order to reduce the costs of speed restrictions further.

Some of the greatest economic costs are generated when projects are forced to shut down or delay as part of a mitigation strategy. During these sometimes prolonged or frequent periods, construction workers are paid to do nothing, seismic survey ships continue to generate running costs while remaining inactive, and contract bonuses can be lost. However, the cost of a missed opportunity to develop a resource may be greater to the industry involved than any of the above. If an oil company cannot survey or construct a platform in an area, they cannot profit from any reserves that are there. This can lead to a perceived loss of income into hundreds of millions of dollars. As a result, the costs incurred due to the use of the various other mitigation tools may be preferable for industries affected in this manner.

Economic costs are not limited to the implementation of specific tools. There are ongoing development costs for many of the mitigation techniques discussed above. Promising new technologies often receive much attention, but established methods are also continuously refined by industries to make them more efficient. One example of the latter is the many tens of millions of dollars invested each year by the seismic industry in the development of improved seismic data acquisition systems. These efforts have resulted in improvements in imaging the deep earth without the need for increasing source levels, as well as reduction in the number of track miles that have to be shot (*i.e.*, a reduction in activity).

Development and installation costs should also be considered for engineering or mechanical modifications, as they may be quite high. This is especially true when the modifications are not factored into initial construction and retrofitting is required. For example, several millions of dollars are invested in the sound source system of each operational seismic boat. With several tens of seismic boats operating globally modifications to this \$50M to \$100M of hardware will be expensive and are not likely to be undertaken without persuasive reasons to do so: these cost could be doubled if any characteristics of the new sound sources cause more harm and another modification is needed. Accordingly, it is crucial to have specific information that the modifications will be beneficial.

Interestingly, development and installation costs are sometime offset by a reduction in running costs for the industry involved. This appears to be the case for ***ship-quieting technologies***.

However any investment in the development and installation of quieter technologies may be balanced against the resulting reduction in continuous mitigation costs, since a reduction in sound production may obviate the need for observers, aerial or shipboard surveys and other mitigation tools.

While a full cost-benefit analysis of each mitigation tool would almost certainly be beneficial, such a task would be complicated and time consuming, thus placing it beyond the capability of this subcommittee. However, Table 1 [submitted as a draft by Lindy Weilgart who notes that these are very rough guesses. In particular, the "Cost" column needs input from noise producers.] represents a rough comparison of the relative economic costs and environmental benefits of various mitigation tools.

[Table to be provided at later date.]

Environmental costs are generally associated with a lack of mitigation in some way, but it is important to realize that this is not always the case. Longer ship tracks, prolonged projects and increased vehicle use (*e.g.*, for land-based observer platforms) are just three examples of the potentially increased environmental costs associated with the use of mitigation tools. In these cases, there is not only an increase in acoustic emissions, but also in air pollution as a result of additional fuel use.

There may also be social costs linked to environmental costs, and it is here that a simple review of the economic costs of mitigation, and indeed of the whole management system, can be incomplete or misleading. Income from tourism and other associated activities are the only market values traditionally recognized, while less direct economic, social, environmental, and cultural benefits of conserving marine mammal populations are often overlooked due to their complexities.[117] For example, any major management decisions affecting the oil and gas industry may have wide-ranging social consequences. It has been shown the communities of coastal Texas are highly dependent on the oil and gas industry in terms of employment and tax revenue.[118] In the same study, the biggest concern in the same region was that environmental degradation might impact tourism to the area, with the overall view of the industry for any individual largely resulting from their perception of the balance of the two for themselves personally.[119] Interestingly, as reported in this study, the industry agreed that environmental improvement over the last two decades has been largely due to federal legislation[120].

a. Examples of Mitigation Costs

- Offshore facility platform decommissioning - Costs (all figures in 2004 Dollars) of offshore facility platform decommissioning in the Pacific OCS Region (POCSR) were estimated to range from $10,291,000 to $129,842,000, totaling $1,007,699,000 for 23 platforms,[121] which works out to an average of $43,813,000 per platform. Associated costs, such as decommissioning relevant onshore pipelines, marine terminals, etc., and the costs of environmental mitigation and authorization were not included in those estimates. Based mainly on Chevrons 4-H decommissioning project (for Platforms Hope, Heidi, Hilda, and Hazel in 1996), an estimate of all environmentally associated costs (not just related to marine mammals), is approximately $550,000 per platform: $300,000 related to NEPA and the California Environmental Quality Act;

$50,000 in marine mammal monitoring; $100,000 for environmental consultants, $50,000 for special biological surveys; and $50,000 in commercial fishing preclusion agreements.[122] Consequently, MMS has calculated that the cost of environmental mitigation related to marine mammals will add a little over 1¼% to the total costs of decommissioning each platform. This proportion will also be much reduced if the other associated costs are taken into account.

- Lamont-Doherty Earth Observatory (LDEO) - Total marine mammal mitigation costs for the 14 *RSV. EWING* cruises during 2003 and 2004 are $1,083,526, not including all reporting costs, which may add approximately $200,000 to the total (see Table 2). LDEO typically spend around $12-13M for ship operations and research in a typical year of *EWING* activity involving 9 or 10 cruises. Averaging about $77,395 (or around $91,500 including average reporting costs) LDEO mitigation activities increase their expenditures for the research by around 6% or 7%). Nearly a quarter of the total of these mitigation costs are for trained, experience NOAA approved individuals acting exclusive as marine mammal observers.

- MMS Costs - The MMS experience costs directly related to their efforts in petitioning for MMPA regulations for mineral extraction-related activities in the Gulf of Mexico. These include structure removal operations and seismic survey activities and have been conservatively estimated to total $8,940,065 over the last 5 years, consisting of $427,436 for completing EAs and EIS, $6,787,629 funding for research, and $1,725,000 in MMS salaries.

- Navy Costs [A summary will be placed here on completion of Table 3.]

Table 2 - Lamont-Doherty Earth Observatory

Total Marine Mammal Mitigation Costs by Cruise: 2003 & 2004

Submission from Mike Purdy

	LDEO Costs	Observer Costs		Consultant Costs			
Cruise Name	Manage-ment & Travel	Salaries	Travel	Permitting & Field	Reporting	Manage-ment	TOTAL
GoM 03 - Jul	$15,549	$6,000	$800	$32,445	$22,770	$9,880	**$87,444**
Hess - Aug	$15,549	$12,150	$3,300	$47,198	$20,496	$9,880	**$108,573**
Norway - Sep	$15,549	$17,100	$5,700	$45,496	$21,756	$9,880	**$115,481**
TAG - Oct	$15,549	$4,275	$4,800	$30,119	$17,437	$9,880	**$82,060**
Bermuda - Nov	$15,549	$2,925	$2,100	$35,845	$1,210	$9,880	**$67,509**
Chicx I - Feb	$15,549	$5,720	$1,395	$61,199	-	$9,880	**$93,743**
SE Carib - Apr/Jun	$15,549	$61,608	$4,279	$95,984	-	$9,880	**$187,300**
Transit I - Jun	None	$3,120	$500	-	-	-	**$3,620**
Transit II - July	None	$11,960	-	-	-	-	**$11,960**
G of AK - Aug/Sep	$15,549	$20,280	-	$57,670	-	$9,880	**$103,379**
KNORR - Aug	$15,549	$8,060	$3,100	$14,770	-	$9,880	**$51,359**
Blanco - Oct	$15,549	$15,600	$3,000	$29,495	-	$9,880	**$73,524**
Transit II - Nov	-	$5,720	$3,000	-	-	-	**$8,720**
Eq. Pac - Dec	$15,549	$28,860	$9,000	$25,565	-	$9,880	**$88,854**
TOTALS	**$171,039**	**$203,378**	**$40,974**	**$485,786**	**$83,669**	**$108,680**	**$1,083,526**
Max	$15,549	$61,608	$9,000	$95,984	$22,770	$9,880	**$187,300**
Min	$15,549	$2,925	$500	$14,770	$1,210	$9,880	**$3,620**
Any $0 costs?	3	0	2	3	9	3	**0**
Ave	$15,549	$14,527	$3,415	$43,253	$16,734	$9,880	**$77,395**
Ave (incl 0)	$12,217	$14,527	$2,927	$33,985	$5,976	$7,763	**$77,395**

The Observers are exclusive marine mammal observers - trained, experienced NOAA approved individuals.

The consultant responsibilities are the same for each cruise:

1. Prepare the documentation for environmental clearances primarily the IHA and ITS from NMFS, but may include local and state special requirements.
2. Based on mitigation requirements of the IHA and ITS, prepare a Marine Mammal Observer Handbook for each cruise.
3. Provide Lead Observer for each cruise. The Lead Observer will be responsible for assigning observer schedules and responsibilities and ensuring that the terms of the IHA are met.
4. Complete the required "90 day Report" and submit to NMFS. ("reporting" costs)
5. Provide, as requested, interpretation and advice on marine mammal issues for future seismic projects or permitting directions (management).

Table 3 – Navy Costs

Submission from Frank Stone

MEASURE	COST – R&D	COST - FLEET	EXAMPLE
Reporting	INMARSAT telephone costs $10/min to call/fax in information real time.	INMARSAT telephone costs $10/min to call/fax in information real time	
Research to improve basic knowledge, evaluate mitigation, or determine the effect of the activity upon marine mammals.	FY03 - $14.06K FY04 - $14.23K FY05 – $10.0 K FY06 – FY11 – planned $10.2K before Congressional Adds.	NA	
Seasonal Restrictions – limits on an activity during annual biologically important periods of time.	Cost to relocate vessel to alternate location. Vessel cost ~$10K/day plus personnel.	Fuel cost to relocate vessel to alternate location.	a) Dec – March: Northern Right Whale calving season. b) April – November protective measures in sea space from Charleston, SC to Sebastian Inlet, FL and out from coast 80 nm.
Geographical Restrictions – limits on an activity within a specified distance of a biologically important habitat, or the habitat of a particularly sensitive species.	Cost to relocate vessel to alternate location. Vessel cost ~$10K/day plus personnel.	Fuel cost to relocate vessel to alternate location.	a) Northern Right Whale Critical Habitat – limited use/avoidance during calving season. b) Great South Channel and Cape Cod Bay Critical Habitat c) Sanctuaries: Key West National Marine Sanctuary (NMS); Gray's Reef NMS; Stellwagen Bank NMS; Monitor NMS; Flower Garden Banks NMS; HI Islands Humpback Whale NMS; Channel Islands NMS; Gulf of the Farallones NMS; Fagatele Bay NMS; Cordell Bank NMS; Monterey Bay NMS; Olympic Coast NMS; NW HI Islands Coral Reef Ecosystem Reserve; NE/NQ Providence Channel – Bahamas; International Med Sea Cetacean Sanctuary; Banc D'Arguin National Park, Mauritania; Greater St. Lucia Wetland Park, South Africa; Greater Vicinity of the Canary Islands

MEASURE	**COST – R&D**	**COST - FLEET**	**EXAMPLE**
Safety Zones	No Cost	No Cost	
Shipboard or Aerial Surveys and other types of observations	Two Shipboard personnel, dedicated to lookout costs ~ 4.5K/daily. Contractor cost may vary. Aerial survey costs are $3.3K/hour for a P-3 aircraft.	No cost for military personnel already standing watch as lookout.	
Temporal Restrictions – Short- term limitations placed on an activity, *i.e.* from 30 min. before sunset to 30 min after sunrise.	Ship/personnel cost for non-testing time. Ship cost ~10K/day plus $2.3K/person per day.	No Cost	
Use of Sound – *i.e.* Ramp-ups, acoustic deterrents and dry fire.	No Cost	No Cost	
Engineering or Mechanical Modifications – changes to usage, *i.e.* limiting the power of an array of airguns or the speed of a vessel. OR research and development, and eventually, modification of equipment, *i.e.* ship quieting.	Limits of source level limits testing objectives. Vessel speed reductions can lengthen time to complete test objective. Ship/personnel cost additions apply. Modifications to ship equipment (*i.e.* shock mounts) are typically already used for scientific testing.		
Shut down or stand down	Cost of ship/personnel.		
Passive Acoustic Monitoring	Cost of recording/processing.		
Active Acoustic Monitoring	Cost of recording/processing.		
Sound Attenuation – *i.e.* bubble curtains, dampening screens and other such devices.	Unknown		
Training and Education – of crew or public as appropriate.	Time and training material.		
Lower limit on aircraft altitude.	Unknown		

3. Examples of Mitigation Requirements By Activity Types[123] [*This information was submitted by NOAA Fisheries. The Subcommittee should discuss its inclusion and possible supplementation - It has been suggested that the lists below is quite limited and that a better alternative might be to take a sample activity and suggest how the mitigation techniques discussed above could/should be applied.*]

There are no generalized mitigation requirements for activities occurring in U.S. waters that "take" marine mammals incidental to their normal operations. Instead, permitting agencies develop mitigation requirements, otherwise known as operational restrictions, on a case-by-case basis depending on the type of activity and the geographic location. Summarized below are the mitigation requirements currently used for specific activities.

Underwater Demolition/Explosives
1. Minimize adverse effects, as possible
2. Explosives measures, including: no charges detonated when mammals are within the safety zone; detonations can only occur during daylight hours (i.e., temporal restrictions); detonations must be delayed if weather and/or sea conditions make monitoring by observers impossible; detonations must be staggered in time for each group of charges.
3. Prohibition on maximum explosive charge (i.e., engineering or mechanical modifications)
4. Real-time determination of sound levels to determine safety zone.

Seismic Exploration – Arctic
1. Minimize adverse effects, as possible
2. Arctic on-ice measures, including: no energy source may be placed over an observed ringed seal lair; activities must be conducted as far as practicable from ringed or bearded seal lairs (i.e., geographic restrictions – *DMA*).

Energy Production[Does this mean oil and gas only?]
1. Evaluate mitigation effectiveness with a research program

Rocket/Missile Launches
1. Minimize adverse effects, as possible
2. Aircraft and helicopter flight paths must maintain minimum altitude (1,000 ft) from seal haul-outs and rookeries (*i.e.*, flight restrictions)
3. Launches must be avoided during harbor seal pupping season (*i.e.*, seasonal restrictions)
4. Launches must be avoided which predict a sonic boom during pupping seasons (*i.e.*, seasonal restrictions)
5. If injurious or lethal take determined during post-launch surveys, launch procedure and monitoring methods must be reviewed (in cooperation with NMFS) and appropriate changes made prior to next launch (*i.e.*, research)

Construction Activities- Arctic
1. Minimize adverse effects, as possible
2. Arctic on-ice measures, including: construction activities (e.g., ice roads) must begin as soon as possible once weather and ice permit activity; ringed seal structures must be avoided by a

minimum distance (492 feet); after March 20, activities should avoid disturbance of any located seal structure (*i.e*., seasonal restrictions)

3. Arctic open-water measures, including: establish 190 dB safety zone for seals and 180 dB safety zone for whales; shut-down or reduction of sound pressure levels when marine mammals sighted within the prescribed safety zones; in order for activities to begin, the entire 180 dB designated safety zone must be visible during the pre-activity monitoring period
4. All non-essential boat, barge, and air traffic will be scheduled to avoid periods when bowhead whales are migrating through the area where they may be impacted by noise from these activities (*i.e*. seasonal restrictions)
5. Helicopter flight paths must maintain a minimum altitude (1,000 feet) and are be limited to a corridor from Seal Island to the mainland (*i.e.,* flight restrictions)
6. All activities must be performed consistent with any signed Conflict Avoidance Agreement with the affected Native communities

4. The Role of Mitigation as Part of a Comprehensive Management Approach

[The Subcommittee should consider describing the purpose and limitations of each component of management, placing each in context in the management system and identifying the management issues involved. The following constitutes a sample of text that could be used to do so for mitigation tools.]

The simplest way to eliminate a sound source is not undertaking the activity that produces it. While it may be possible to reduce some sound-producing activities by using alternatives that serve the same purpose (e.g., using simulations instead of active sonar exercises for naval training operations), global economic and political needs prevent us from simply stopping all human activities in the marine environment. It may be possible in some cases to eliminate acoustic by-products e.g., through ship-quieting technology), but many signals are deliberately introduced into the ocean to accomplish a specific goal.[124] Consequently, modifications and alternatives, restrictions, or other mitigation of sound sources are required to limit their impacts on marine mammals and their environment. [*It was suggested that this paragraph would fit well in the introduction since it gives a great picture of the perfect system (no noise) but explains practically why that is not possible*].

Unfortunately, the effectiveness of even commonly used mitigation measures (e.g. ramp-up and safety zones) have generally not been assessed and evaluated, and can vary greatly from species to species. Furthermore, any mitigation effort can only be effective if it is appropriately applied. A recent study showed that the presence of a ”dedicated marine mammal observer” (defined for that study as “someone with experience of marine mammal observations, dedicated to that task alone, for which this is a usual role”) generally lead to greater compliance with pre-seismic marine mammal survey, observance of a safety zone, and ramp ups (or “soft-starts”) in comparison to the presence of a fisheries liaison officer, or only the crew, which displayed the least compliance.[125] Similar trends were seen with regards to correct data reporting, mean number and distance to sightings, species identification, and other aspects of data detail and quality. The duration of marine mammals surveys is also important: if they are only done or required for a small fraction of the time that sound is being produced, these surveys may be of limited value.

Partly due to the various limits to the effectiveness and acceptability of each mitigation tool, it is widely accepted that there is not, and probably never will be, a single "silver bullet" solution to this issue. The potential application of a fully integrated systems that bring together a combination, if not all, of the tools at our disposal is likely to be the only way to maximize an efforts strengths and weaknesses. As a result, there may be significant improvements in our ability to mitigate acoustic effects upon marine mammals.

Finally, it is important to consider the repercussions of the use of any particular mitigation tool. For example, the playback of recorded sounds produced by natural predators as an acoustic deterrent has demonstrated some success, but also carries the potentially fatal possibility of habituation (i.e. they later ignore a real predator[126]).

F. Enforcement, Compliance, and Reporting

An essential component of any management system is the systematic examination of the extent to which legal and regulatory mandates are effectively implemented. Without adequate enforcement, legal requirements and the regulations that implement those requirements may not be effective in achieving their statutory goals (*e.g.,* conserving marine mammals). For example, if a mitigation tool required under permit conditions is not properly used, or not used at all, then it will never reduce the impacts of a sound on marine mammals. The enforcement of relevant U.S. statutes and regulations is generally carried out by the permitting agencies (*e.g.*, NOAA Office for Law Enforcement) and the U.S. Coast Guard. Largely because of the difficulties inherent in policing the oceans, many enforcement efforts focus on the prevention of offenses (*e.g.*, through outreach and education), rather than prosecution of violations. Enforcement activities include patrols and applications of technology (*e.g.*, cameras) to monitor for violations, investigations of violations, and communication with interest groups and the general public (*e.g.*, educating and encouraging self-policing and reporting).

Compliance with current statutory requirements can be assessed and encouraged in a variety of ways, including the use of several of the methods employed in enforcement activities, as well as financial or other incentives, education, and outreach. Currently, enforcement of the regulations pertaining to the protection of marine mammals is often initiated by reports of non-compliance from a member of the public.[127] As a result, prosecutions or other remedial actions are not usually possible due to lack of evidence.[128] However, the discovery of physical evidence alone, such as a stranded animal, does not necessarily mean that there was an incidence of non-compliance. Compliance can also be assessed through self-monitoring and self-reporting by the sound producers, but reliance on these strategies may not be effective and could result under-reporting of violations.

Reporting is an essential component of management, especially in cases where the capacity to enforce regulations, permit conditions, or other requirements is limited. In general, the agencies require that those undertaking an action under existing permitting programs provide a variety of information, including, but not limited to, actual field sound propagation patterns, the general behavior of marine mammals in and around the area of activity, and any evidence of takes. However, as noted above, self-reporting without external verification can be problematic.

Non-compliance may result from a lack of basic knowledge about the impacts on marine mammals, as in the case of many Floridian boaters with regard to the rational behind manatee speed zones.[129] Accordingly, public outreach (including positive reinforcement) and education may improve compliance, as has been seen in the case of Hawaiian whale watching operators who were educated about acoustic-related approach regulations.[130] In this case whale watching boats observed to be well outside the 100-yard minimum approach distance were also contacted whenever possible to acknowledge their efforts to comply with regulations.[131] The Hawaiian whale watching vessels report recommends a continued presence of uniformed enforcement officers, both on and off the water; continued public outreach, with advertisements in airlines and local magazines in order to educate otherwise unreachable tourists; and that positive reinforcement continue.

Economic incentives may also be effective at inducing compliance. For example, the oil and gas industry is spending large amounts of money every year in efforts to improve efficiency, reduce the number of ship tracks needed to survey an area, and develop improved methods for detecting marine mammals, as achieving all of the above will save them money in the long run. It may also be possible for the government to economically motivate industries to use particular mitigation tools through tax incentives or other means.

More proactive enforcement, such as the presence of uniformed enforcement officers and regular patrols, has been shown to improve compliance with regulations[132]. However, such efforts are costly; USFWS spent $1.4M on the enforcement of manatee protection requirements (predominantly related to ship strikes) in 2003 and 2004, and recovered very little through boater citations ($23,000 in 2003)[133]. Similar proactive enforcement efforts for many sound producing activities may be considerably more expensive if they are undertaken further from the coast, making then inaccessible to the shore-based enforcement efforts. In some cases, it may be possible to station officers with sound producers, but this would require a large investment in manpower and still be impractical for more widespread activities, such as shipping (should it ever become subject to marine mammal-related regulations).

G. Monitoring and Evaluation

Once a management action or plan of any sort has been implemented, it is necessary to appraise the outcomes of the various components of the system. For example, such evaluations should examine compliance with the mitigation requirements and other permit conditions, the effectiveness of the mitigation strategies applied, any level of take during the activity, and field verification and validation of the various assumptions. To achieve this, the agencies generally require monitoring and follow-up reporting for small take authorizations and permits. The sound producers themselves generally obtain this information, which allows an evaluation of the management efforts to take place to further refine project-specific mitigation requirements, and future requirements, through adaptive management. If such monitoring is to be useful in the evaluation of efficacy, the detailed reports and observations on which they are based must be carefully tailored to answer the following key questions:

- Were the mitigation requirements carried out in full?
- What occurred during the management and/or mitigation efforts?
- How effective and appropriate were those efforts in accomplishing their purpose?

Were the mitigation requirements carried out in full?
In cases where only self-monitoring and self-reporting occur, it may be difficult to assess whether all requirements were fully met, and compliance may become problematic. It is therefore useful to include external review and verification processes in any self-reporting system.

What occurred during the management and/or mitigation efforts?
To determine what has occurred, monitoring of the behavior, abundance, and distribution of marine mammals prior to, during, and after periods of activity should be undertaken. A comparison of the observations made prior to the activity with those made after its conclusion, for example, may reveal short-term changes in marine mammal behavior and abundance. These observations are important, but any changes from the "norm" that are detected will only reflect the impact of the mitigated activity. As a result, the impacts of an unmitigated activity and the extent to which the management or mitigation efforts may have tempered these impacts cannot be distinguished.

To determine these separate effects, experiments using control areas (*i.e*., areas where no activity has taken place) and comparisons between mitigated and unmitigated activities are needed. Such experiments are subject to two major problems. First, there would be many regulatory barriers to conducting activities without mitigating for effects. Secondly, due to the large variation between sites, years and seasons, the periods of non-activity, unmitigated activity, and mitigated activity would best be undertaken in the same location, all taking place within a short time-frame. As a result, the results of the second exposure could be influenced by the first.

Consequently, the use of monitoring data alone can never conclusively determine the effectiveness of a management or mitigation effort. However, repeated and long-term monitoring can begin to suggest efficacy and may be the only way to investigate impacts that are not instantaneous. Accordingly, the time invested in such monitoring efforts is important, as short, sporadic surveys are not going to provide as much information about or evidence of, the impacts associated with an activity.

How effective and appropriate were those efforts in accomplishing their purpose?
It is important to realize that, even if a management effort meets its immediate goals, it may not be effective at achieving its overall purpose. For example, the purpose of an observer-maintained safety zone is to make sure that marine mammals stay far enough away from the source to be unaffected by it. A measurable goal would be to keep them outside a defined range. Determining if the zone achieves this goal could be done through monitoring the distance from the sound source at which marine mammals are first sighted. If all the marine mammals are first spotted before or as they enter the safety zone, then the zone's goals are being achieved. If a high proportion of animals are not sighted until they are well within the safety zone, then the methodology is ineffective. Regardless of this, if the determination of the original range is

flawed, the overall purpose (*i.e.*, to prevent impacts on marine mammals) may not be fulfilled and the measure is not effective.

Establishing efficacy is therefore not easy, and may involve monitoring animals well beyond the predicted zone of influence, accurately mapping the acoustic field of any source as environmental conditions vary, and identifying all the potential mechanisms of impact. Fortunately, the effectiveness of new techniques that become available can, to some extent, be compared with those of earlier technologies and methodologies, providing a measure of relative effectiveness.

V. Policy Issues

A. Jurisdictional Issues

Introduction

Efforts to manage and mitigate acoustic impacts on marine mammals are complicated by the number and kind of legal regulatory mechanisms that exist or have been proposed. This complication is manifest in at least three jurisdictional areas: (1) some sound sources are regulated while others are not, (2) the range of legal mechanisms in the U.S. that apply to sources that are regulated is multifaceted and sometimes less than clear, and (3) managing sound sources and marine mammal populations that are global in scope may require international approaches, but there is jurisdictional ambiguity due to the absence of effective management regimes at the international level.

Non-regulated and regulated sources

The section of this report on Sound-Generating Activities Subject to Management (III) outlines the sound producing activities and sources that are not currently regulated in the U.S. Among those sources and activities are acoustic deterrent and harassment devices used in the fishing industry, large vessel noise, commercial airliners, commercial/research sonars, echosounders, and icebreaking. Many marine mammal researchers and geophysical researchers have noted that they may be unfairly penalized by being subject to regulation of their sound-producing activities, when other sources, perhaps with larger impacts, are not.

Addressing non-regulated sound sources that impact marine mammals through appropriate management and mitigation must be viewed from both the international and national perspectives. Making the assumption that existing regulatory mechanisms can effectively incorporate additional (currently unregulated) sources may be unwise. For example, new requirements to include current non-regulated sources in existing permitting programs may cause these programs to collapse from the addition of large numbers of new small take authorization applications. Furthermore, a number of currently non-regulated sources are only recently beginning to understand their impacts on marine mammals. Assuming that jurisdictional issues will only be overcome in a long-term evolutionary process, the following [recommendations] [suggestions] are made to move this issue to a more timely and constructive resolution.

(1) Compile a list of non-regulated sound sources impacting marine mammals globally

(2) Develop and implement outreach programs to non-regulated sources, including information on the nature of the problem, impacts of the sources on marine mammals, and potential solutions to mitigate these impacts.

(3) Identify existing national systems that currently have legal authority to mandate control strategies over non-regulated sources.

(4) Identify existing international systems that currently have legal authority to mandate control strategies over these non-regulated sources.

(5) Include systems that focus on both mammal-based and source-based control strategies/systems in all evaluations.

(6) Think outside the box! Are existing structures sufficient to accommodate a potentially wide variety of source types operating in a wide variety of marine environments or are new structures necessary?

Complexity of Legal Mechanisms in U.S. ("Patchwork of Regulations")
The permitting requirements outlined in this report provide multiple avenues for regulatory management and oversight of sound producing activities. The legislation that guides these regulatory efforts is in some cases overlapping and highly specific about how certain activities should be managed, while it is silent on the management of other sound producing activities. Discussions in the Subcommittee have noted that the level of oversight does not always coincide with the level of risk to the marine mammals.

[FOR FUTURE DRAFTING, PERHAPS ADD SOMETHING ABOUT PERMITTING SYSTEMS ISSUES. SEE RECOMMENDATIONS FROM WORKING GROUP ON PERMITTING IMPROVEMENTS.]

International Jurisdictional Issues
While national requirements may address sound in the marine environment (particularly in coastal and continental shelf waters), neither marine mammals nor sound sources respect boundaries imposed by legal systems that must be used to effectively implement and enforce those requirements. For example, few marine mammal species have distributions restricted to the waters of the Exclusive Economic Zone of any one country. There has been considerable debate and discussion about whether international fora must be identified or created to provide an international system to address management and mitigation of sound in the marine environment in a globally meaningful and effective manner.

At present, measures to manage the impacts of human activities on the marine environment internationally are a result of a patchwork of national, regional, and international instruments. For instance, the European Union directs marine protection efforts largely through its Habitats Directive, yet there exists no overall, integrated policy for marine protection across member nations, let alone a policy for the regulation of anthropogenic sound in the marine environment. In addition, regional conventions aimed at protecting the marine environment, while in some cases legally binding, are difficult to enforce. Consequently it is unclear whether the aggregate of these measures is sufficient to afford the desired level of protection and conservation, or even whether the desired level of protection can be agreed upon globally.

However, several existing legislative instruments aimed at protecting and conserving marine resources, as well as preventing, mitigating and managing sources of pollution should be considered when attempting to address anthropogenic sound throughout the world's oceans. Examples of these instruments include[p]:

<u>Regional Seas Agreements</u>

ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black and Mediterranean Sea and Atlantic contiguous area)

The ACCOBAMS Scientific Committee has identified various sources of anthropogenic sound as causes for concern and action. In 2003, the Committee issued its Recommendation 2.7 on Man Made Noise.[134] This document recommends, among other things, that, pending further research and guidelines on the deployment of sonar, "ACCOBAMS parties consult with any profession using such acoustic devises, including military activities, and urge that extreme caution be exercised in their use in the ACCOBAMS area, with the ideal being no further use until satisfactory guidelines are developed."[135]

ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas)

ASCOBANS has begun to address undersea noise pollution in its *Conservation and Management Plan*, which is annexed to the Agreement. This Annex sets forth mandatory conservation measures to be applied to cetaceans, including "the prevention of . . . significant disturbance, especially of an acoustic nature."[136] Building on this requirement, the Fourth Meeting of Parties to the ASCOBANS Convention, in 2003, passed a resolution entitled "Effects of Noise and of Vessels." Among other things, this resolution requests that Parties take a series of steps to reduce the impact of noise on cetaceans from seismic surveys, military activities, shipping vessels, acoustic harassment devices, and other acoustic disturbances.[137]

OSPAR-Convention for the Protection of the Marine Environment of the North-East Atlantic

The OSPAR Convention is aimed at protecting the marine environment from human-made pollution, including energy, and several OSPAR documents have approached the problem of underwater sound as a form of pollution having adverse effects on the marine environment. "Noise disturbance" is listed among the potentially dangerous effects of human activities that may need to be regulated within or in the vicinity of marine protected areas (MPAs) in order to

[p] This list of international and regional instruments is not meant to be exhaustive. In fact, regional seas agreements, that may be relevant to the regulation and management of ocean noise, exist in virtually all parts of the world. See: **http://www.unep.org/water/regseas/regseas.htm#_actionplan**

achieve the objectives of MPA designation, and, further, is recognized by the OSPAR Commission as among the potentially harmful effects of human activities posing threats to several species of whale.[138] Further, at its most recent meeting, the OSPAR Commission recognized the need to further assess pollution from undersea noise “raised by offshore activities” and directed its Secretariat to prepare a report to its Offshore Industry Committee on this topic.[139]

Framework Agreements

United Nations Convention on the Law of the Sea (UNCLOS)

UNCLOS establishes a globally recognized regime dealing with all matters relating to the uses of the oceans and seas and their resources. UNCLOS assigns the fundamental obligation and responsibility for protecting and preserving the marine environment to States, and requires them to adopt and enforce national laws and international standards to prevent, reduce and control ocean pollution from any source. The convention defines “pollution” to include harmful energy, and thus could be interpreted to encompass sound pollution within its mandates.

Other International Agreements

Convention on Biological Diversity (CBD)

The Preamble of the CBD notes that: "Where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat." Moreover, parties whose activities may pose grave or imminent danger or damage to biological diversity are required to notify potentially affected states, and must take action to prevent or minimize such damage (Art. 14(1)(d)).

International Convention on the Prevention of Pollution from Ships (MARPOL)

Pollution from energy sources (and therefore sound) is not included within MARPOL’s scope, which defines pollution to include only harmful substances. Limitations on undersea sound from shipping therefore cannot be managed by IMO through MARPOL unless a modification to the convention is adopted. In order to use MARPOL to regulate anthropogenic sound, it would be necessary to amend Article 1(1) to include sound.

International Convention on the Regulation of Whaling (ICRW)

Much controversy surrounds the competence of the International Whaling Commission (IWC) to enact measures for the conservation of any species outside the context of commercial whaling. However, the IWC can be an effective forum within which to bring attention to the issue of ocean noise, and the need for its regulation and further study. For instance, Resolution 1998-6 of the International Whaling Commission (IWC) identified “anthropogenic noise” as a priority topic for investigation within its Scientific Committee, and the IWC Scientific Committee, in its report to the 56th meeting of the IWC (July 2004), concluded that there is now compelling evidence implicating military sonar as a direct impact on whales, in particular on beaked whales. The Committee also agreed that evidence of increased sounds from other sources, including ships and seismic activities, was cause for serious concern.

Furthermore, other regional and international agreements, such as the International Convention for the Safety of Life at Sea (SOLAS), do not necessarily fall into one of the above categories, but may be relevant to addressing ocean noise, and should therefore be explored as potential instruments for managing and mitigating anthropogenic sound in the world's oceans.

B. Adaptive Management

All the monitoring and evaluation described above would be of no use without the incorporation of new information into the management plan (*i.e.*, feedback). To achieve this, a management plan must be flexible or adaptive. Adaptive management can be defined as: "The cyclical process of systematically testing assumptions, generating learning by evaluating the results of such testing, and further revising and improving management practices".[140]

Adaptive management programs should be designed to meet clear goals, incorporate periodic reevaluation of these goals and the effectiveness of management measures, and integrate new information. Therefore, to successfully implement adaptive management, monitoring and evaluation must occur for long enough to determine if the predicted effects were achieved. Consequently, the philosophy of adaptive management is most effective for long-term management plans, as short-term efforts tend to be less flexible, and thus less successful because there is less time to incorporate new information.[141] NEPA reviews provide an opportunity for some feedback, but it may also be beneficial to allow for more immediate, mid-course corrections, without requiring new or supplemental NEPA reviews. This would allow mitigation efforts to respond more rapidly to any impacts that vary from those that were predicted and mitigated against.

Crucially for acoustic impacts on marine mammals, adaptive management offers a framework in which to deal with high degrees of uncertainty. As so little information is widely accepted in this area, any regulatory starting point will be viewed as more appropriate by some interest groups than others. The revisions to this starting point permitted by an adaptive approach help to address this problem. Adaptive management provides an opportunity to combine monitoring and decision-making in a way that will better ensure protection of the environment and attainment of societal goals.

Adaptive management is generally assumed to be relatively expensive, with costs arising from many areas including model development, fieldwork to supplement knowledge gaps, and establishing or increasing monitoring programs.[142] However, if the original regulatory decisions were based upon a precautionary approach, it is quite possible that measures taken in the face of uncertainty may turn out to be overly protective and unnecessarily restrictive of human activity. Without the feedback provided by adaptive management, these restrictions, and their comparatively large economic consequences,[143] could not be relaxed in the face of new information.

The same applies to extreme management strategies that are sometimes needed to protect the most threatened populations or species.[144] In these cases adaptive management holds the key to not only the survival of that species, but also to an easing of restrictions when a population begins to recover. Emergency management measures tend to be onerous for those restricted by them and generally require legislative backing (*e.g.*, the Interstate Fisheries Management Plan for the Striped Bass after the stock crashed[145]). However, uncertainty in historic and current abundance estimates,[146] combined with changes in abundance that may be a result of natural variation,[147] make it difficult to establish the extent to which a population has "recovered" with any confidence. This determination generally requires a long-term record of abundance for the population, with interpretations of abundance data becoming more certain the longer the period of monitoring.[148]

C. Target of Concern/Management

One of the major challenges in conservation is the determination of the particular unit or units targeted by management efforts.. Should the effects of anthropogenic sound on an individual animal be of primary concern, or would it be more appropriate to concentrate on stock- or population-level effects? In some cases, monitoring and quantifying the effects of sound on an individual can be relatively simple compared to evaluating the overall impact on a population. In addition, managers might interpret a lack of evidence of negative impact on an individual to mean that there will be few problems at a population-level. However, there are situations where a stock- or population-level effect could be present, but either not be manifested through reactions by individuals, or not be readily observed at the individual level. For example, if the average ambient noise level (at appropriate frequencies) increases, the effective communication distances of marine mammals may be exponentially reduced. This could lead to social problems and possibly a reduction in reproductive success for the population without generating an observable "take" in any single member of that population.

In some cases, management targeted to the stock- or population-level can be more appropriate. However, there are several problems with management efforts focused at this level, not least of which are difficulties in defining exactly what constitutes a stock or population. This requires a reasonably detailed understanding of population structure and the ecosystems in which they occur. For most marine mammals, our knowledge of population structure is seriously lacking. For example, a population or stock might present itself in the form of a clearly defined pod or family group, but these units often interact with other pods in a larger social network. Alternatively, a population might be defined simply as all members of a group that breeds in a single location

Advances in genetic techniques are rapidly improving our ability to study and identify populations. As more becomes known about populations, management strategies will have to adjust in order to achieve their conservation goals. However, even if our understanding of population structure allows us to successfully define a stock- or population-level unit of concern, challenges remain in detecting effects at that level.

The target of concern or management is not only a biological and logistical issue, but also a legal issue (see legislation section). How does management effectively match their conservation units with the obligations set forth in legislation? A lack of biological knowledge and impact assessment techniques can lead to failure to meet these obligations at the legally appropriate level of concern. The investigation of marine mammal population structure must be enhanced if scientists and managers are to appropriately delineate units for management.

D. Statutory Changes (e.g. PBR)

E. Management of Cumulative and Synergistic Impacts

Individual activities, such as research cruises or ship-shock trials, tend to be the focus of management efforts, but in the real world, human activities that affect marine mammals do not happen in a vacuum. Scientists have identified concerns about the impacts that sound sources from a variety of human activities (shipping, seismic exploration, military exercises, etc.) could have cumulatively, over time. There is also serious concern that anthropogenic sound acts in combination with other environmental stressors, such as toxic contaminants, potentially leading to negative synergistic effects.[149]

Unfortunately, under current management practices, cumulative and synergistic impacts tend to fall through the cracks. Regulations adopted under the NEPA, for example, require agencies to consider the cumulative impacts of past, present, and reasonably foreseeable future activities in preparing environmental impact statements;[150] in practice, however, the data available on other activities and the resources available to evaluate them are often severely limited. This problem is not specific to anthropogenic sound, of course, but anthropogenic sound, with its myriad of sources and effects, presents a particularly difficult case. The present situation may exemplify what the ecologist William Odum called "the tyranny of small decisions" – the fragmentation of environmental policy into many discrete, seemingly independent policies, in such a way that the big picture is lost.[151]

Programmatic review can be a useful way of bringing multiple, related activities under the umbrella of a single analysis. The U.S. Commission on Ocean Policy has endorsed the idea of programmatic analysis for permitting decisions made under the MMPA,[152] and both NEPA and the MMPA already allow for broader review, though under somewhat different standards.[153] But there are also drawbacks to this approach. If the scope is too broad, analysis suffers;[154] this may especially be true of programmatic reviews that attempt to encompass a variety of geographic regions. If the review is not carefully organized, or "tiered," with a series of analyses moving from broad to specific, each one rigorous in itself and carefully relating to the next, the benefits of the approach may be lost. And because of quirks within the current process, certain stages of review may not be open to effective public input or oversight, which are important checks on quality. All of these problems must be resolved if programmatic analysis is to become standard operating procedure.

One further drawback to programmatic review is its limited scope. There are constraints on the range of activities that such a review could comprise, either under the MMPA or under NEPA, and under some circumstances it may not be possible for a single document to consider the cumulative impacts of diverse noise sources or the synergistic impacts of noise and stressors related to other developments. It has been suggested that, to get at the full range of issues, the current system of activity-based review should be supplemented or modified by processes that focus on marine mammal populations or habitat, so that, for example, all impacts on the California gray whale or on the Southern California Bight would be considered in one process.

But there are obstacles to this approach as well. Most populations of marine mammals off the coast of the United States are not well defined; many of the potential impacts that sound could have on marine mammals, such as behavioral disturbance and non-lethal injury, are difficult to assess, making it difficult to establish thresholds beyond which take should not be allowed to occur; rights to produce intense sound in certain beleaguered areas may be hard to apportion; and the sheer breadth of activities to be accounted for may easily result in a dilution of analysis.

In short, programmatic review and habitat-based regulation are worth pursuing, though care should be taken to ensure that these efforts do not effectually reduce protections for marine mammals.

F. Others to be added

VI. Potential Recommendations

Box 1: NOAA Fisheries Permit Application Information Requirements

To satisfy their information needs, NOAA Fisheries require that applications for small take authorizations must include the following:

(1) A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals;

(2) The date(s) and duration of such activity and the specific geographical region where it will occur;

(3) The species and numbers of marine mammals likely to be found within the activity area;

(4) A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities;

(5) The type of incidental taking authorization that is being requested (i.e., takes by harassment only; takes by harassment, injury and/or death) and the method of incidental taking;

(6) By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in paragraph (5) of this section, and the number of times such takings by each type of taking are likely to occur;

(7) The anticipated impact of the activity upon the species or stock of marine mammal;

(8) The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses;

(9) The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat;

(10 The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved;

(11) The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance;

(12) Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses.

(13) The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding. Guidelines for developing a site-specific monitoring plan may be obtained by writing to the Director, Office of Protected Resources; and

(14) Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

[1] As amended; 16 USC 1361 et seq.
[2] 16 U.S.C. § 1361(l), (3)
[3] 16 USC 1361
[4] 16 USC 1362 (13)
[5] 16 USC 1362 (18)
[6] 16 USC 1362 (22)
[7] 16 USC 1371 (5)(A)
[8] as amended; 16 USC 1531 et seq.
[9] 16 USC 1531 (a)(3-4)
[10] 16 USC 1536 (a)(2)
[11] 16 USC 1536, as detailed by joint regulations published in 50 CFR 402
[12] 16 USC 1536 (a)(2)
[13] 16 USC 1538
[14] 16 USC 1538 (a)(1)
[15] 16 USC 1532 (19)
[16] see 16 USC 1533 (d)
[17] 16 USC 1536 (h)(1)(B)
[18] 16 USC 1543
[19] 42 USC § 4321 et seq.
[20] 42 USC 4321
[21] 42 USC 4332 (C)
[22] 42 USC 4332 (C)
[23] 40 C.F.R. 1502 (22)
[24] 40 C.F.R. 1502 (14)
[25] 43 USC 1331 et seq.
[26] As amended; I6 USC 1451 et seq.
[27] 16 USC 1452 (1)
[28] 16 USC 1456 (c)(1)(C)(2)
[29] 15 CFR 930.122
[30] 15 CFR 930.122
[31] 33 USC 1501 et seq.
[32] 42 USC 9101 et seq.
[33] 33 USC 403 et seq.
[34] 16 USC 1151 et seq.
[35] 16 USC 1152
[36] 30 USC 1901 et seq.
[37] Presidential Proclamations 5928 and 7219
[38] Underwood and Chapman, 1999
[39] Policansky, 1998
[40] CBD, 2004
[41] MMC, 2004 – Future Directions
[42] *Taylor (1993)*
[43] Taylor, 1993; Taylor et al., 2000
[44] CBD, 2004
[45] i.e. BWWR, 2004 – Colin MacLeod
[46] Cite AIM and ESME
[47] Information Provided by Donna Wieting, NOAA
[48] MMPA sec. 101 (a)(5)
[49] MMPA sec. 101 (a)(5)
[50] MMPA sec. 101(a)(5)(D)
[51] MMPA sec. 101(a)(5)(A)
[52] MMPA sec. 104(c)(3)
[53] MMPA sec. 104

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[54] ESA sec. 7(a)(2)
[55] ESA sec. 7(b)(4)
[56] Information Provided Sara Wan and Mark Delaplaine, CCC
[57] Information Provided by Colleen Corrigan, USFWS
[58] Beaked Whale Report, 2004
[59] Waring, G. T. , Hamazaki, T., Sheehan, D., Wood, G., and Baker, S. 2001. Characteristics of beaked whale (Ziphiidae) and sperm whale (Physeter macrocephalus) summer habitat in shelf-edge and deeper waters off the Northeast United States. Mar. Mamm. Sci. 17 (4): 703-717.
[60] Harwood, 2002
[61] Russell, 2001
[62] Clapham and Pace, 2001
[63] LGL Proposal To The Canadian Government – MJ to supply full citation at later date
[64] Tolstoy et al. 2004
[65] JNCC, 2004
[66] Herman et al., 2003
[67] Herman et al., 2003
[68] Russell, 2001
[69] Barlow and Gisiner, 2004
[70] Pierson et al, 1998
[71] Pierson et al, 1998; Barlow and Gisiner, 2004
[72] Pierson et al, 1998
[73] Barlow and Gisiner, 2004
[74] Barlow and Gisiner, 2004
[75] see Stone, 2003
[76] JNCC 2004
[77] Pierson et al, 1998
[78] Pierson et al, 1998
[79] Pierson et al, 1998
[80] Perham and Williams, 2003
[81] Perham and Williams, 2003
[82] Amstrup et al., 2004
[83] Amstrup et al., 2004
[84] Barlow and Gisiner, 2004
[85] Smith et al., 2004
[86] Wursig et al. 1998 – Aquatic Mammals
[87] R.R. Reeves, et al., (eds.). Acoustic deterrence of harmful marine mammal-fishery interactions: Proceedings of a workshop held in Seattle, Washington, 20-22 March 1996 (Washington, D.C.: U.S. Department of Commerce, 1996) (NOAA Tech. Memo. NMFS-OPR-10)
[88] Pierson et al, 1998; Barlow and Gisiner, 2004
[89] Pierson et al, 1998
[90] Nelson, D.R., and S.H. Gruber, "Sharks: Attractions by low-frequency sounds," Science 142 (1963): 975-77; Nelson, D.R., and R.H. Johnson, "Acoustic attraction of Pacific reef sharks: Effect of pulse intermittency and variability," Comp. Biochem. Physiol. 42A (1972): 85-95.
[91] Barlow and Gisiner, 2004
[92] Stone, 2003
[93] Stone, 2003
[94] JNCC, 2004
[95] Evans, 1998
[96] Jefferson and Curry, 1996
[97] Jefferson and Curry, 1996; Barlow and Gisiner, 2004
[98] Nowacek et al., 2004
[99] Jefferson and Curry, 1996
[100] JNCC, 2004; LGL proposal to Canadian government
[101] Barlow and Gisiner, 2004
[102] MMC, 2004 – Beaked Whale Report; Future Directions Report; NRC, 2000; Evans and Miller, 2004

[103] W. John Richardson, pers. comm.. and Møhl, B. 2004. Sperm whale sonar rivals tactical sonar with source levels at 235 dB. pp. 41-42. In: Evans, P. G. H. and Miller, L. A. (Eds.). Proceedings of the Workshop on Active Sonar and Cetaceans, European Cetacean Society Newsletter, No. 42—Special Issue.
[104] JNCC, 2004
[105] Pierson et al, 1998
[106] Barlow and Gisiner, 2004
[107] Barlow and Gisiner, 2004
[108] JNCC, 2004
[109] Barlow and Gisiner, 2004
[110] Barlow and Gisiner, 2004
[111] Jonathon Stein, Permit
[112] Barlow and Gisiner, 2004
[113] Barlow and Gisiner, 2004
[114] Russell, 2001; Barlow and Gisiner, 2004
[115] Wursig et al., 2000
[116] Kite-Powell and Hoagland, 2002
[117] CBD, 2004
[118] Kelley, 2002-MMS
[119] Kelley, 2002-MMS
[120] Kelley, 2002-MMS
[121] MMS, 2004-Offshore Facility Decom. Report
[122] MMS, 2004-Offshore Facility Decom. Report
[123] Information Provided by Donna Wieting, NOAA
[124] Barlow and Gisiner, 2004, Pew Oceans Commission, 2003
[125] Stone, 2003
[126] Jefferson and Curry, 1996
[127] Herman et al., 2003, FWS Office of Law Enforcement pers. comm.
[128] Herman et al., 2003
[129] Aipanjiguly et al., 2003
[130] Herman et al., 2003
[131] Herman et al., 2003
[132] Herman et al., 2003, FWS Office of Law Enforcement pers. comm., Aipanjiguly et al., 2003
[133] FWS Office of Law Enforcement pers. comm.
[134] Report of the Second Meeting of the Scientific Committee to ACCOBAMS, Istanbul, 20-23 November 2003, Annex 34g, Recommendation 2.7 (2003).
[135] *Id.*
[136] ASCOBANS, Annex, para. 1(d).
[137] Fourth Meeting of Parties to ASCOBANS, Res. 5 *Effects of Noise and of Vessels* (2003).
[138] *See* OSPAR Commission, *Guidelines for the Management of Marine Protected Areas in the OSPAR Maritime Area* (2003); OSPAR Commission, *Case Reports for the Initial List of Threatened and/or Declining Species and Habitats in the OSPAR Maritime Area* at 91.
[139] OSPAR Commission, Draft Summary Record, OSPAR 2004 (OSPAR 04/23/1-E) Annex 20, 2004/05 Product 17.
[140] Pomeroy et al., 2004 – See Jim Ray
[141] see Castilla, 2000
[142] Walters, 1997
[143] see Gerber et al., 1999-Conservation Biology
[144] Gerber et al., 2000-American Scientist
[145] Richards and Rago, 1998
[146] Gerber et al., 2000-American Scientist
[147] Underwood and Chapman, 1999
[148] Gerber et al., 1999-Conservation Biology
[149] International Whaling Commission, 2004 Report of the Scientific Committee (2004): Chairman's Summary, Annex K.
[150] 40 C.F.R. § 1508.7.

[151] Odum, W.E., “Environmental degradation and the tyranny of small decisions,” BioScience 32 (1982): 728-29.
[152] U.S. Commission on Ocean Policy, *An Ocean Blueprint for the 21st Century: Final Report of the U.S. Commission on Ocean Policy* (2004): Chapter 20.
[153] 40 C.F.R. §§ 1502.4, 1502.20, 1508.18(b)(3) (NEPA regulations);16 U.S.C. §§ 1371(a)(5)(A), (D) (MMPA).
[154] Council on Environmental Quality, *Considering Cumulative Effects under the National Environmental Policy Act* (1997).